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Lessons Learned Using Standards-Based Decision Support Frameworks in Commercial EHRs: Opioid Decision Support Case Study

Kensaku Kawamoto, MD, PhD, MHS
Associate CMIO, University of Utah

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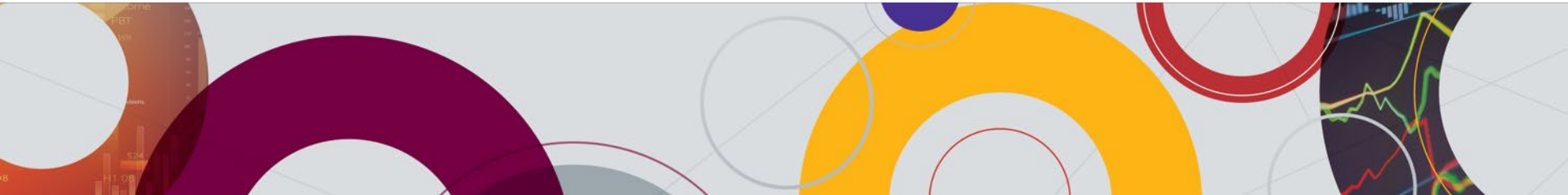
Associate CMIO, Yale New Haven Health

Bryn Rhodes
Principal, Dynamic Content Group

Cole Erdmann
Director, Clinical Intelligence, Cerner



Agenda

Panelist	Topic
Kensaku Kawamoto, MD, PhD, MHS Associate CMIO, University of Utah	Need for interoperable opioid CDS Project overview and initial Utah pilot
Bryn Rhodes Principal, Dynamic Content Group	Standards & EHR vendor support Standards-based knowledge artifacts
Nitu Kashyap, MD Associate CMIO, Yale New Haven Health	Pilot #1 (Epic, Yale, CDS Hooks)
Cole Erdmann Director, Clinical Intelligence, Cerner	Pilot #2 (Cerner, Indiana University, CQL)
All	Interactive discussion

Disclosures

CE is an employee of Cerner

In the past year, KK has served as a consultant, sponsored researcher, or invited speaker with honorarium for the U.S. Office of the National Coordinator for Health IT (via Security Risk Solutions), Hitachi, McKesson InterQual, Klesis Healthcare, RTI International, and UC San Francisco

In the past year, BR has served as a consultant or invited speaker with honorarium for the U.S. Office of the National Coordinator for Health IT (via Security Risk Solutions (SRS) and Enterprise Science and Computing (ESAC)), Centers for Medicare and Medicaid (via ESAC), Centers for Disease Control (via SRS), World Health Organization, National Committee for Quality Assurance, Apervita, McKesson, RTI International, and Oregon Health & Science University.

The other presenters have no disclosures

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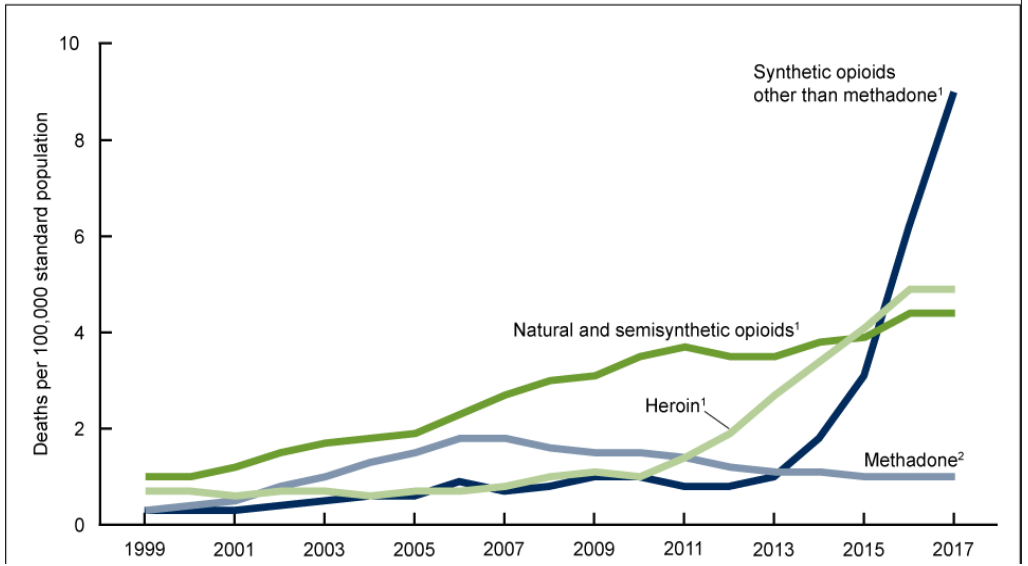
Project Overview and Initial Utah Pilot

Kensaku Kawamoto, MD, PhD, MHS, FACMI, FAMIA
Associate CMIO
Vice Chair for Clinical Informatics, Dept. of Biomedical Informatics
Director, ReImagine EHR
University of Utah

OPIOID EPIDEMIC

- >700,000 drug overdose deaths, 1999-2019 (>70,000 in 2019)
- >60% involve opioids
- 130 deaths from opioid overdose/day
- Deaths from Rx opioid ↑ 6x since 1999

Figure 4. Age-adjusted drug overdose death rates, by opioid category: United States, 1999–2017



https://www.cdc.gov/drugoverdose/epidemic/index.html
https://www.cdc.gov/nchs/products/databriefs/db329.htm

CDC PRESCRIBING GUIDELINE

- For opioid use for chronic pain outside of active cancer treatment, palliative care, or end-of-life care

https://www.cdc.gov/drugoverdose/prescribing/guideline.html

CDC OPIOID DECISION SUPPORT PROJECT

- Goal: provide point-of-care support for CDC Guideline for Prescribing Opioids for Chronic Pain
- CDC-sponsored effort. Contributors: ONC, AHRQ, Yale, Indiana University, Duke, Security Risk Solutions, Epic, Cerner, and many others.
- Approach:
  - Leverage health IT standards for representing clinical knowledge & integrating into EHR
  - Pilot with multiple healthcare organizations and EHR products

STANDARDS-BASED DISSEMINATION

- **EHR data retrieval: HL7 FHIR**
  - FHIR = Fast Healthcare Interoperability Resources
- **Guideline knowledge representation: HL7 CQL**
  - CQL = Clinical Quality Language
- **EHR workflow integration: HL7 CDS Hooks**
  - CDS = clinical decision support
- **EHR app integration: HL7 SMART**
  - SMART = Substitutable Medical Apps, Reusable Technologies
- **Key enabler: EHR vendor support for these standards**

Determining when to initiate or continue opioids for chronic pain

1. Opioids are not first-line therapy
2. Establish goals for pain and function
3. Discuss risks and benefits

Opioid selection, dosage, duration, follow-up, and discontinuation

4. Use immediate-release opioids when starting
5. Use the lowest effective dose
6. Prescribe short durations for acute pain
7. Evaluate benefits and harms frequently

Assessing risk and addressing harms

8. Use strategies to mitigate risk
9. Review PDMP data
10. Use urine drug testing
11. Avoid concurrent opioid and benzodiazepine prescribing
12. Offer treatment for opioid use disorder

Source: https://www.cdc.gov/drugoverdose/pdf/guidelines_at-a-glance-a.pdf

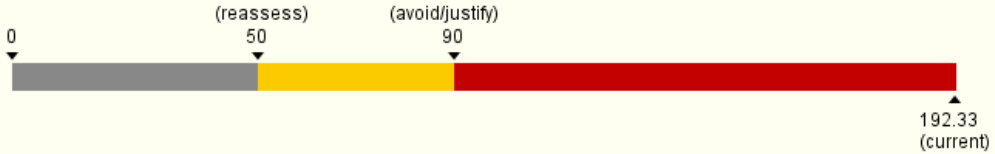
OVERVIEW OF PILOTS

- **Pilot with Custom Infrastructure: University of Utah**
  - With SMART on FHIR and custom CDS Hooks infrastructure layered on top of Epic Best Practice Advisory Web service infrastructure
  - Recommendation #5 (lowest effective dosing)
- **Pilot with Native EHR Infrastructure, #1: Epic / Yale**
  - With CDS Hooks, recommendations #10 (drug testing) & 11 (benzo)
- **Pilot with Native EHR Infrastructure, #2: Cerner / Indiana U.**
  - With CQL in population health management platform
  - Recommendations #10 and 11
- **Pilot with Native EHR Infrastructure, #3: Epic / Duke**
  - With CDS Hooks, recommendations #10 and 11

BestPractice Advisory - Testpatient,Opioid1

Patient's average oral morphine equivalence (OME) is 192.33 mg/day.

Daily Average OME (mg/day)



For adults, CDC recommends reassessing evidence of individual benefits and risks when increasing dosage to >= 50 OME/day, and avoid increasing dosage to >= 90 OME/day or carefully justifying such a decision.

Active Opioid Rx	Avg OME/day*
New **Oxycodone Hydrochloride 15 MG Oral Tablet**	**135 mg**
FENTANYL CITRATE 200 MCG BU LPOP	**17.33 mg**

⚠ Verify taking; Rx may have expired

Sig: Place 1 each (200 mcg) inside cheek every 2 hours as needed. Use prior to bowel movements, maximum 4 per day

Morphine equivalence: 130x. For 1 lozange, OME = 26 mg.

Rx by Smith, John on 02/07/18. Disp 20 each, Refills 0.

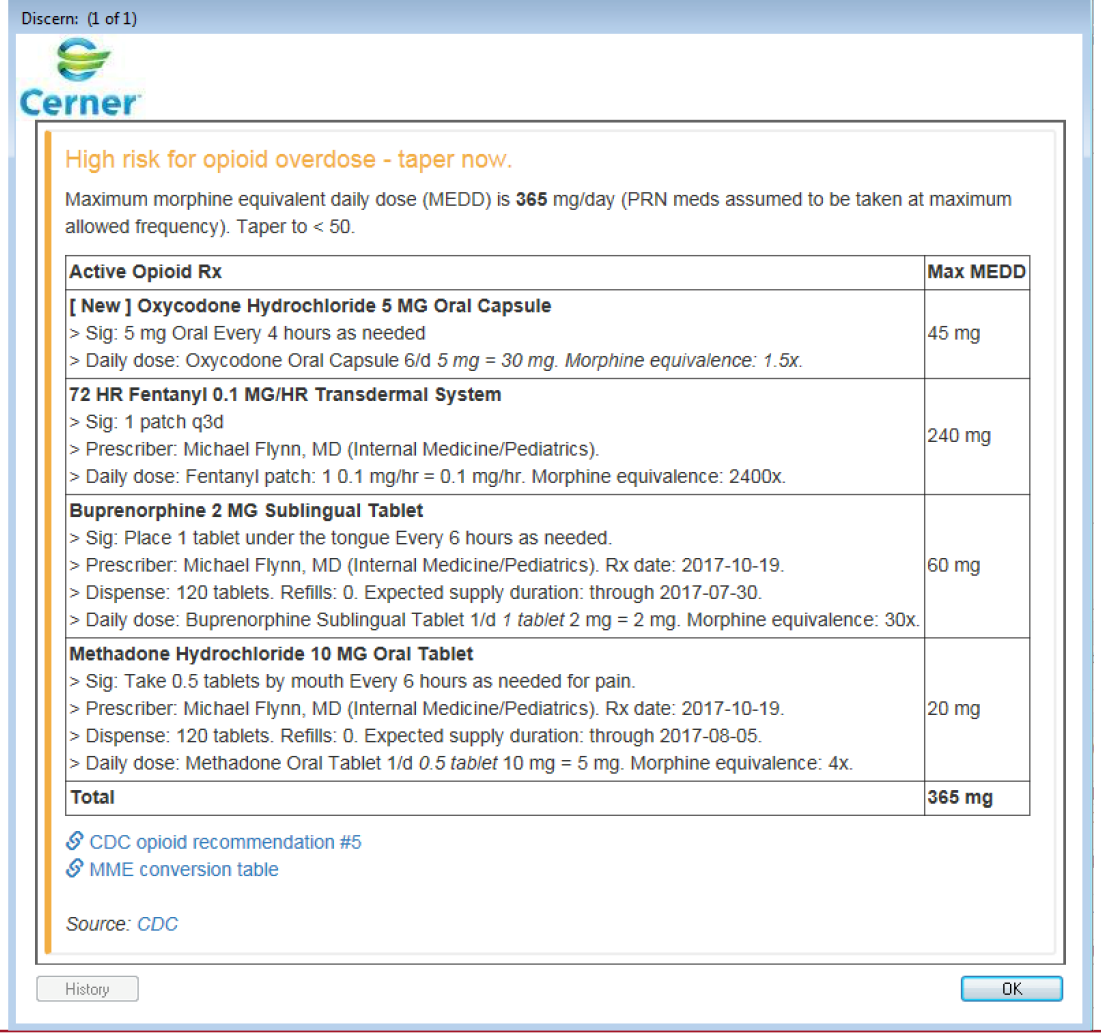
Start date: 02/07/18. End date (estimated): 02/12/18. Based on dispense quantity and max daily dose in sig.

Daily dose (avg): Fentanyl Oral Lozenge 20 dispense * 0.2 mg / 30d supply (assumed) = 0.13 mg.

Daily dose (max): Fentanyl Oral Lozenge 4 (daily max per sig) * 0.2 mg = 0.8 mg.

Accept Cancel

HEALTH UNIVERSITY OF UTAH



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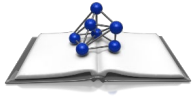
CDS Standards Overview and Use for Standards-based Knowledge Artifacts

Bryn Rhodes
Principal
Dynamic Content Group

Quality Improvement Ecosystem

1. RESEARCH, PAYER & PUBLIC HEALTH SURVEILLANCE

What is happening and why?



2. GUIDELINES
(Professional Societies, CDC, etc.)

What SHOULD happen. What do we want to happen?

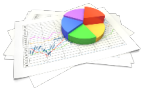
3. CLINICAL DECISION SUPPORT

MAKING it happen within local workflow.

4. CLINICAL CARE

Clinician and Patient Workflow.

Patient, provider, population, public



5. MEASUREMENT ANALYTICS

What DID happen? What processes and outcomes have been achieved?

6. REPORTING

- Public Health
- Quality
- Safety

Current Guideline Development and Implementation

Long Implementation Time

Develop guidelines

Research Results

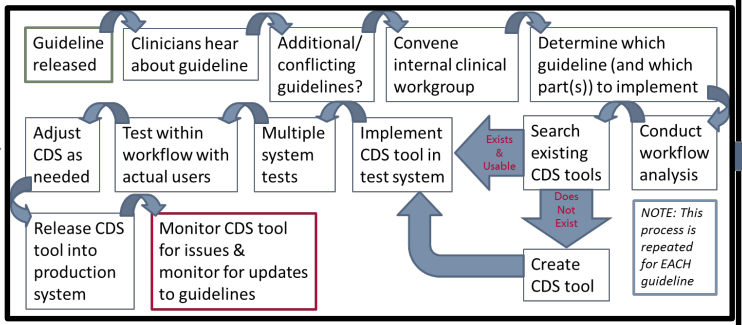
Literature Review

Meta-analysis

Guideline Narrative

PDF

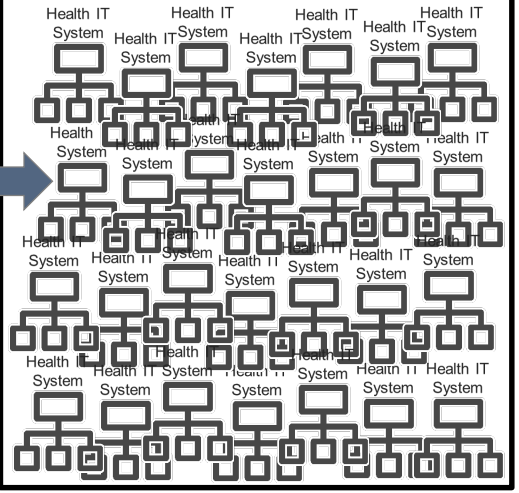
Interpret guidelines



Performed by up to 96% of ~5500 hospitals

Performed by up to 86% of ~355,000 MDs

Implement guidelines

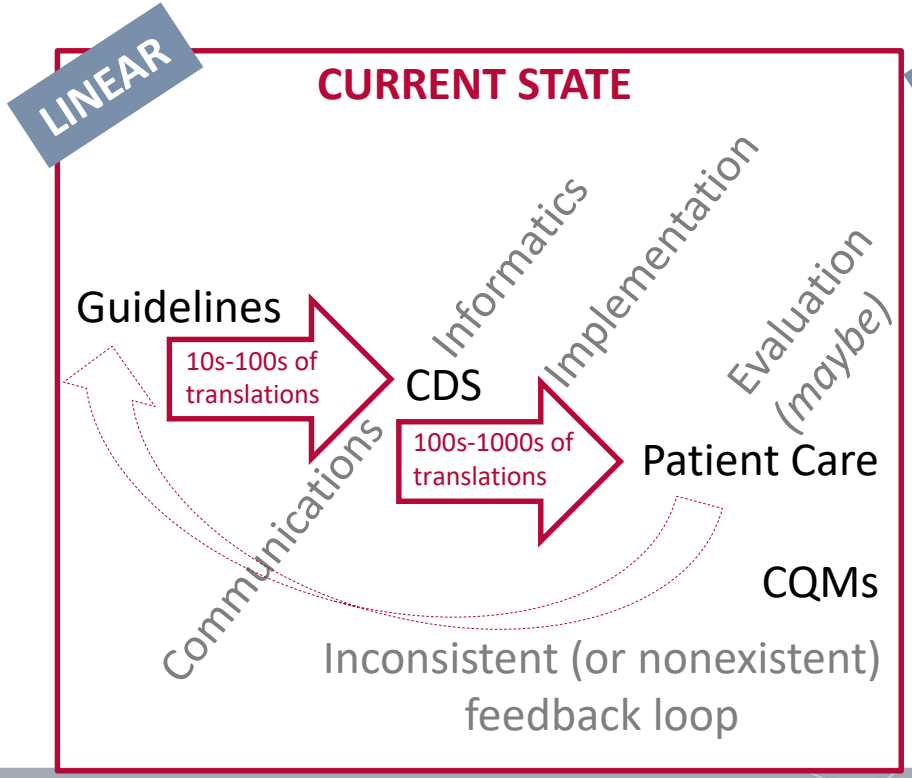


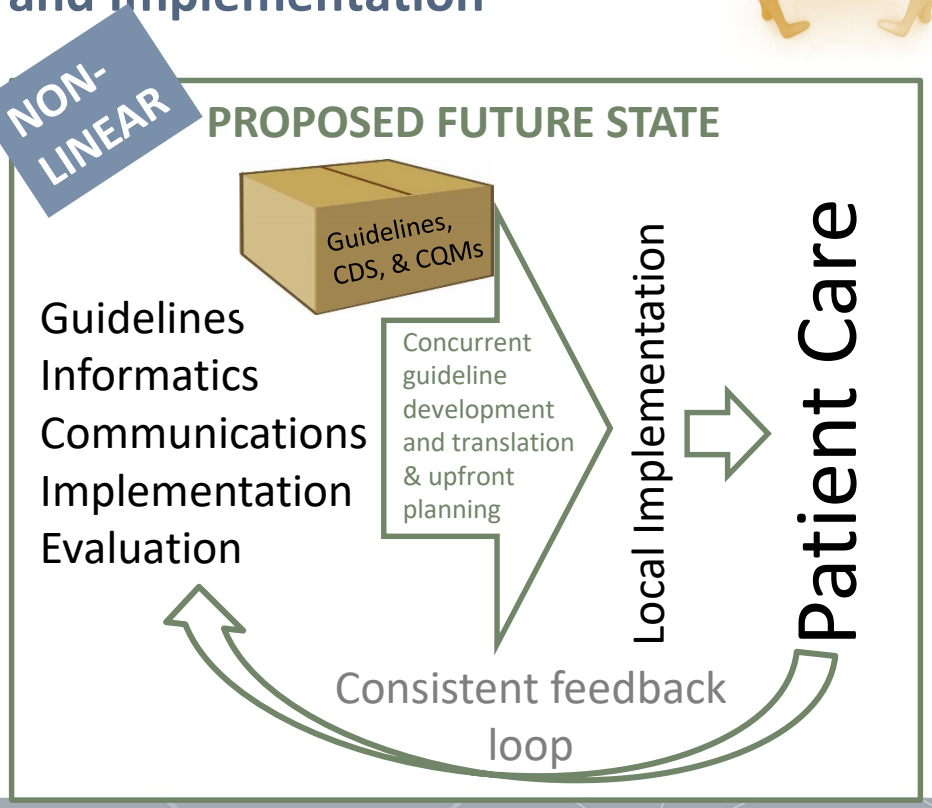
https://dashboard.healthit.gov/quickstats/quickstats.php

Slide courtesy of Maria Michaels, Centers for Disease Control and Prevention

Adapting Clinical Guidelines for the Digital Age:

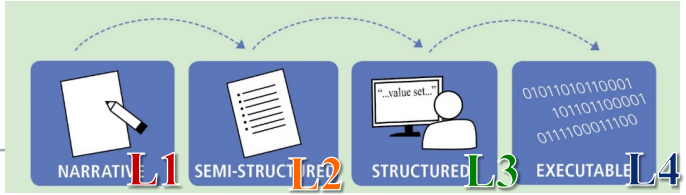
Redesigning Guideline Development and Implementation





Slide courtesy of Maria Michaels, Centers for Disease Control and Prevention https://www.cdc.gov/ddphss/clinical-guidelines/index.html

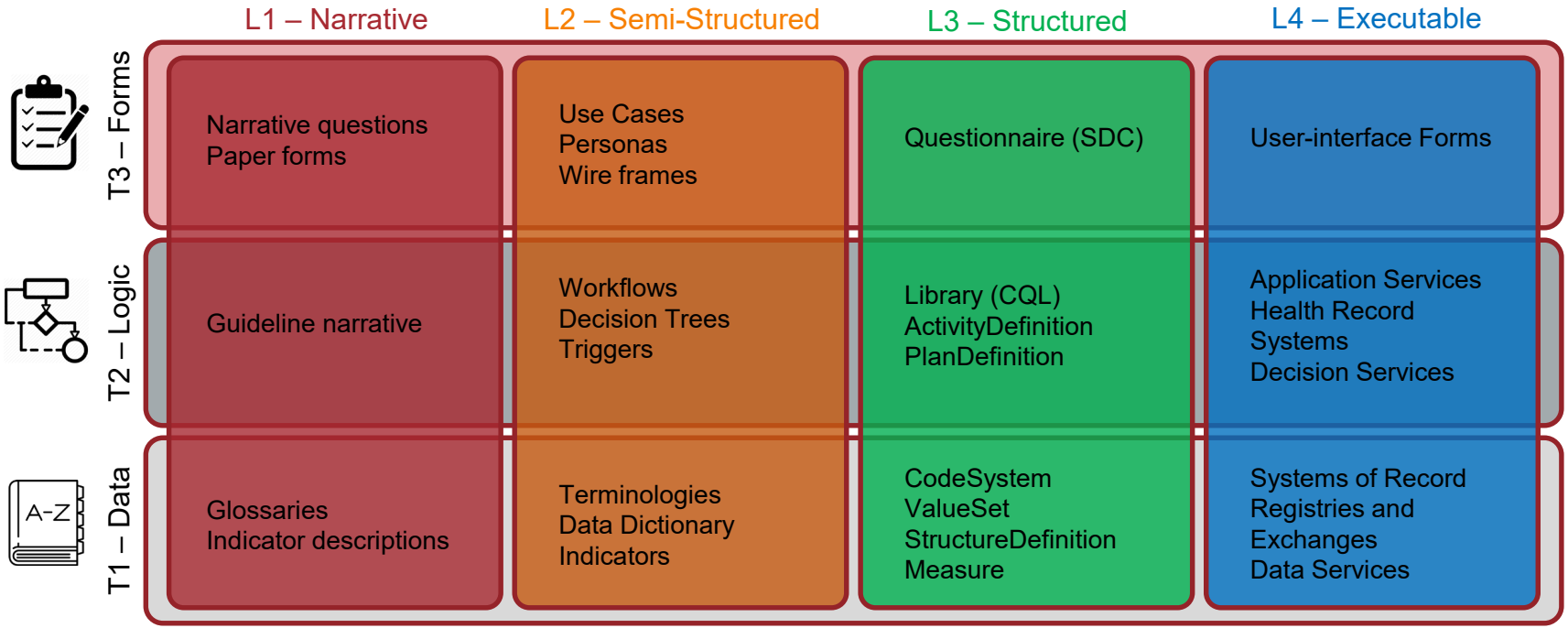
Translating Evidence to Executable CDS



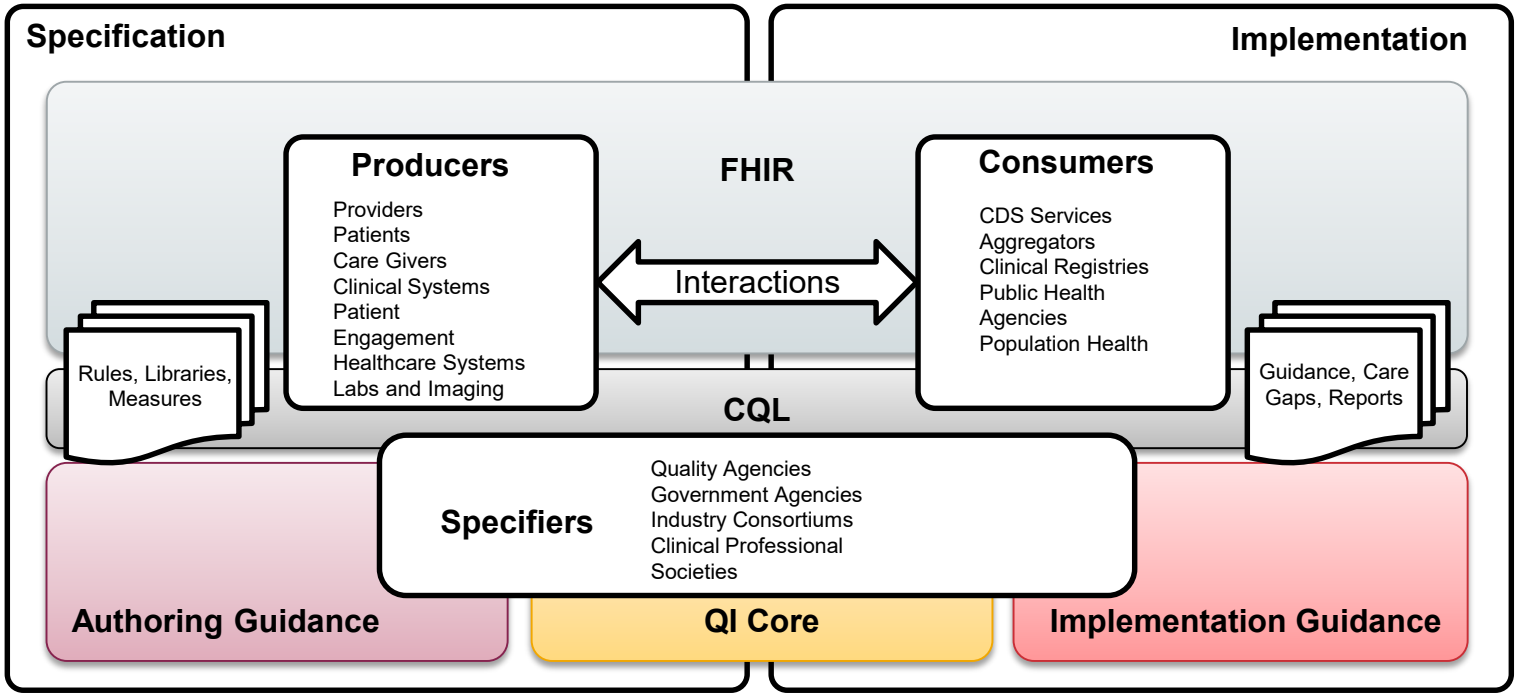
Knowledge Level	Description	Example
L1	Narrative	Guideline for a specific disease that is written in the format of a peer-reviewed journal article
L2	Semi-structured	Flow diagram, decision tree, or other similar format that describes recommendations for implementation **(HUMAN READABLE)**
L3	Structured	Standards-compliant specification encoding logic with data model(s), terminology/code sets, value sets that is ready to be implemented **(COMPUTER/MACHINE READABLE)**
L4	Executable	CDS implemented and used in a local execution environment (e.g., CDS that is live in an electronic health record (EHR) production system) or available via web services

Adapted from: Boxwala, AA, et al.. A multi-layered framework for disseminating knowledge for computer-based decision support. *J Am Med Inform Assoc* 2011(18) i132-i139.

Requirements to Running Code



Quality Improvement Standards



HL7 FHIR

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Fast **H**ealthcare **I**nteroperability **R**esources

Resources – Building blocks (provide *syntax*)

Profiles – Usage descriptions (provide *semantics*)

Protocol – Defines interactions

Layers in FHIR

FOUNDATION

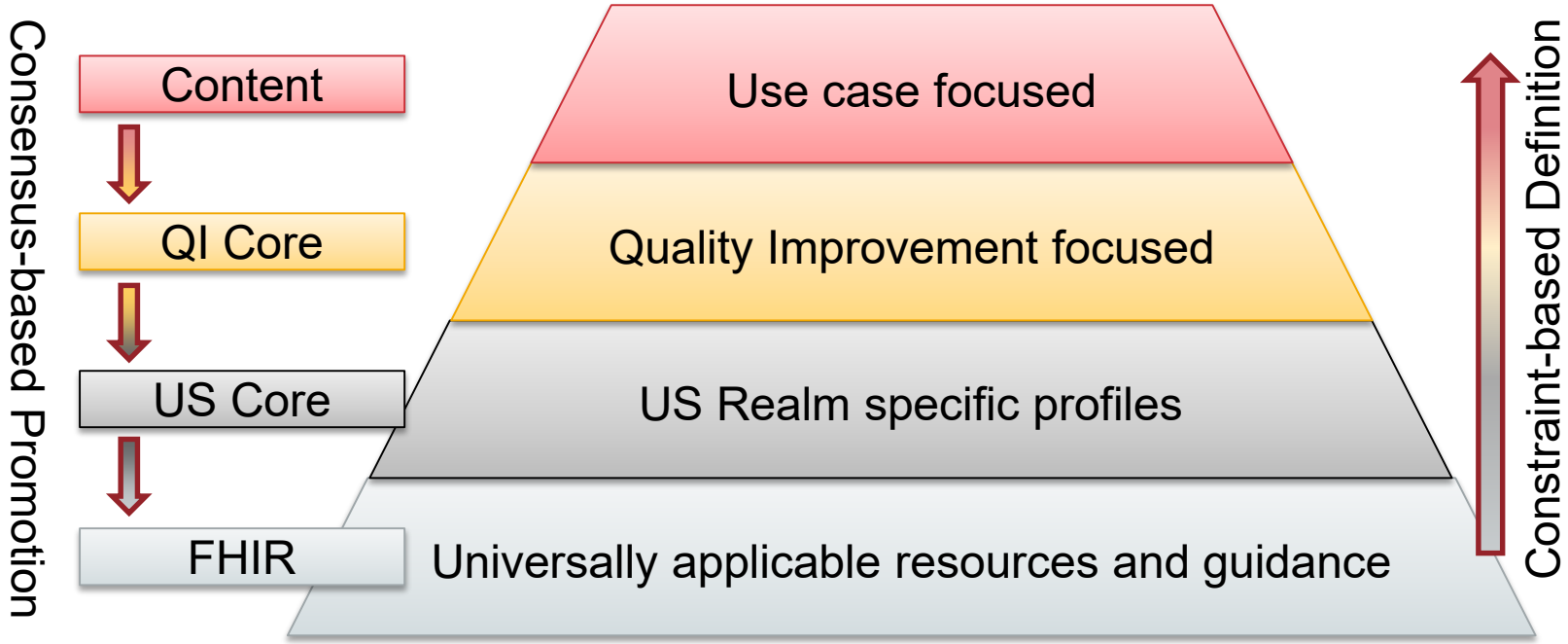
CONFORMANCE

ADMINISTRATION

CLINICAL

REASONING

Data Model Standards



Clinical **Q**uality **L**anguage

Health Level 7(HL7) standard designed to:

- Enable automated point-to-point sharing of executable clinical knowledge
- Provide a clinically focused, author-friendly, and human-readable language

Currently a Standard for Trial Use (STU) publication

CQL is a Query Language

Decision support and quality measurement are fundamentally ***calculations***, i.e. some formula, expressed in terms of clinical data elements, that results in a ***value***

CQL uses the concept of ***expressions*** to represent these calculations

Expressions can be simple values, or they can be sophisticated queries involving many different operators, functions, and references to other expressions

The key is that every expression returns a ***value***, and every value is of some ***type***

Recommendation #10 Snippet

```
50  context Patient
51
52  define "Lookback Year":
53    Interval[Today() - 12 months - 1 days, Today() - 1 day]
54
55  define "Inclusion Criteria":
56    AgeInYears() >= 18
57      and exists (Common."Active Ambulatory Opioid Rx")
58      and AnyTrue(Common.ProbableDaysInRange(Common."Active Ambulatory Opioid Rx", 90, 80))
59      and
60        ("No Urine Screening In Last 12 Months"
61          or "Has Evidence of Opioids"
62          or "Has Evidence of Illicit Drugs")
63
64  define "Illicit Drug Urine Screenings in Last 12 Months":
65    (
66      [Observation: "code" in Common."Illicit Drug Screening"] IllicitDrugScreen
67        where date from IllicitDrugScreen.effective in day of "Lookback Year"
68    ) IllicitDrugScreenDuringLookback
69      sort by effective.value
```

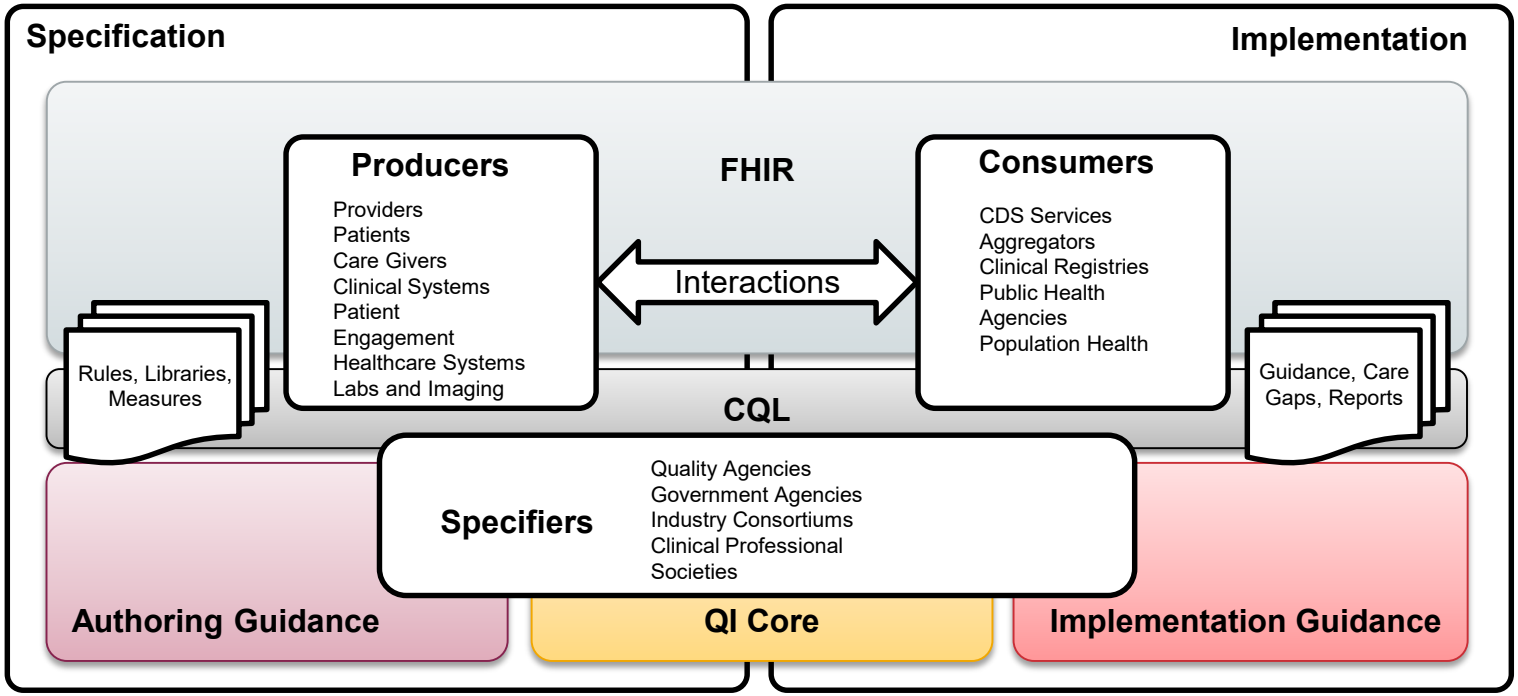
Recommendation #11 Snippet

```
define "Inclusion Criteria":
  AgeInYears() >= 18
    and (
      exists (Common."Active Ambulatory Benzodiazepine Rx")
        and exists (Common."Active Ambulatory Opioid Rx")
    )

define "Get Indicator":
  if "Inclusion Criteria"
    then 'warning'
  else null

define "Get Summary":
  if "Inclusion Criteria"
    then 'Patient has active prescriptions for opioid pain medication and benzodiazepines'
  else null

define "Get Detail":
  if "Inclusion Criteria"
    then 'Avoid prescribing opioid pain medication and benzodiazepines concurrently whenever possible'
  else null
```

Recommendation #11 – Detected Issue

```
// Detected Issue - Avoid prescribing opioid pain medication and benzodiazepines concurrently
define "Concurrent Benzodiazepine Prescription Issue":
  DetectedIssue {
    status: FHIR.ObservationStatus { value: 'preliminary' },
    category: FHIR.CodeableConcept { text: FHIR.string { value: "Get Summary" } },
    severity: FHIR.DetectedIssueSeverity { value: 'moderate' },
    patient: FHIR.Reference { reference: FHIR.string { value: 'Patient/' + Patient.id } },
    date: FHIR.dateTime { value: Now() },
    implicated:
      (Common."Active Ambulatory Benzodiazepine Rx"
        union Common."Active Ambulatory Opioid Rx") M
        return FHIR.Reference { reference: FHIR.string { value: 'MedicationRequest/' + M.id } },
    detail: FHIR.string { value: "Get Detail" },
    reference: FHIR.uri { value: 'http://fhir.org/guides/cdc/opioid-cds/PlanDefinition/opioidcds-11-patient-view'}
  }
```

Quality Improvement Standards



Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

SEARCH

CDC A-Z INDEX

Opioid Overdose

- Opioid Overdose
- Opioid Basics +
- Data +
- Overdose Prevention +
- Information for Patients +
- Information for Providers −
  - **Guideline Overview**
  - Guideline Resources +
  - Training for Providers +

CDC > Opioid Overdose > Information for Providers

CDC Guideline for Prescribing Opioids for Chronic Pain

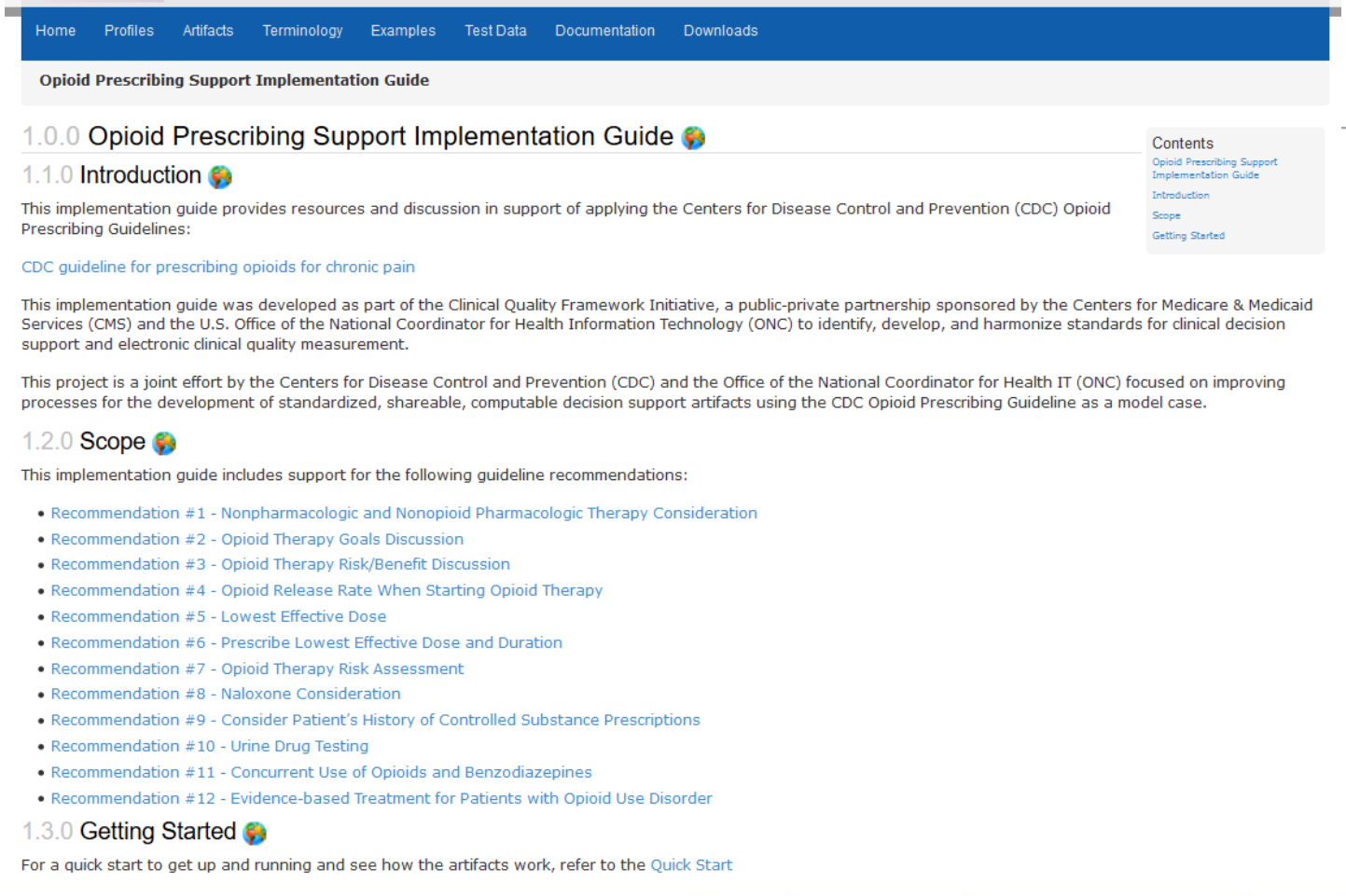
Improving the way opioids are prescribed through clinical practice guidelines can ensure patients have access to safer, more effective chronic pain treatment while reducing the number of people who misuse, abuse, or overdose from these drugs.

CDC developed and published the *CDC Guideline for Prescribing Opioids for Chronic Pain* to provide recommendations for the prescribing of opioid pain medication for patients 18 and older in primary care settings. Recommendations focus on the use of opioids in treating chronic pain (pain

Guideline Recommendations

Guideline for Prescribing Opioids for Chronic Pain: Recommendations [PDF – 674 KB]

https://www.cdc.gov/drugoverdose/prescribing/guideline.html



Home Profiles Artifacts Terminology Examples Test Data Documentation Downloads

Opioid Prescribing Support Implementation Guide

1.0.0 Opioid Prescribing Support Implementation Guide

Contents

1.1.0 Introduction

This implementation guide provides resources and discussion in support of applying the Centers for Disease Control and Prevention (CDC) Opioid Prescribing Guidelines:

CDC guideline for prescribing opioids for chronic pain

This implementation guide was developed as part of the Clinical Quality Framework Initiative, a public-private partnership sponsored by the Centers for Medicare & Medicaid Services (CMS) and the U.S. Office of the National Coordinator for Health Information Technology (ONC) to identify, develop, and harmonize standards for clinical decision support and electronic clinical quality measurement.

This project is a joint effort by the Centers for Disease Control and Prevention (CDC) and the Office of the National Coordinator for Health IT (ONC) focused on improving processes for the development of standardized, shareable, computable decision support artifacts using the CDC Opioid Prescribing Guideline as a model case.

1.2.0 Scope

This implementation guide includes support for the following guideline recommendations:

- Recommendation #1 - Nonpharmacologic and Nonopioid Pharmacologic Therapy Consideration
- Recommendation #2 - Opioid Therapy Goals Discussion
- Recommendation #3 - Opioid Therapy Risk/Benefit Discussion
- Recommendation #4 - Opioid Release Rate When Starting Opioid Therapy
- Recommendation #5 - Lowest Effective Dose
- Recommendation #6 - Prescribe Lowest Effective Dose and Duration
- Recommendation #7 - Opioid Therapy Risk Assessment
- Recommendation #8 - Naloxone Consideration
- Recommendation #9 - Consider Patient's History of Controlled Substance Prescriptions
- Recommendation #10 - Urine Drug Testing
- Recommendation #11 - Concurrent Use of Opioids and Benzodiazepines
- Recommendation #12 - Evidence-based Treatment for Patients with Opioid Use Disorder

1.3.0 Getting Started

For a quick start to get up and running and see how the artifacts work, refer to the Quick Start

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http://build.fhir.org/ig/cqframework/opioid-cds-r4/

- Functional Description
- Process Flow
- Computable Content
- Test Cases

Home Profiles Artifacts Terminology Examples Test Data Documentation Downloads

Opioid Prescribing Support Implementation Guide

8.16.0 Recommendation #11 - Concurrent Use of Opioids and Benzodiazepines

Contents

Recommendation #11:

Clinicians should avoid prescribing opioid pain medication and benzodiazepines concurrently whenever possible *(recommendation category: A, evidence type: 3)*.

8.16.1 Functional Description

Patient is being prescribed opioids for chronic pain.

Patient does not appear to be at end of life.

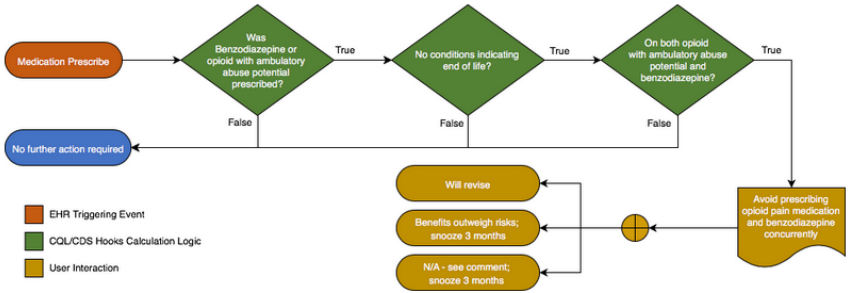
If patient is prescribed opioid medication concurrently with Benzodiazepine medication, provide a recommendation to revise order:

Avoid prescribing opioid pain mediation and benzodiazepine concurrently whenever possible.

Provide links to the CDC Guidance.

One of the following responses should be required:

- Will revise order.
- Risk of overdose carefully considered and outweighed by benefit; snooze 3 months.
- N/A-see comment (will be reviewed by medical director); snooze 3 months.



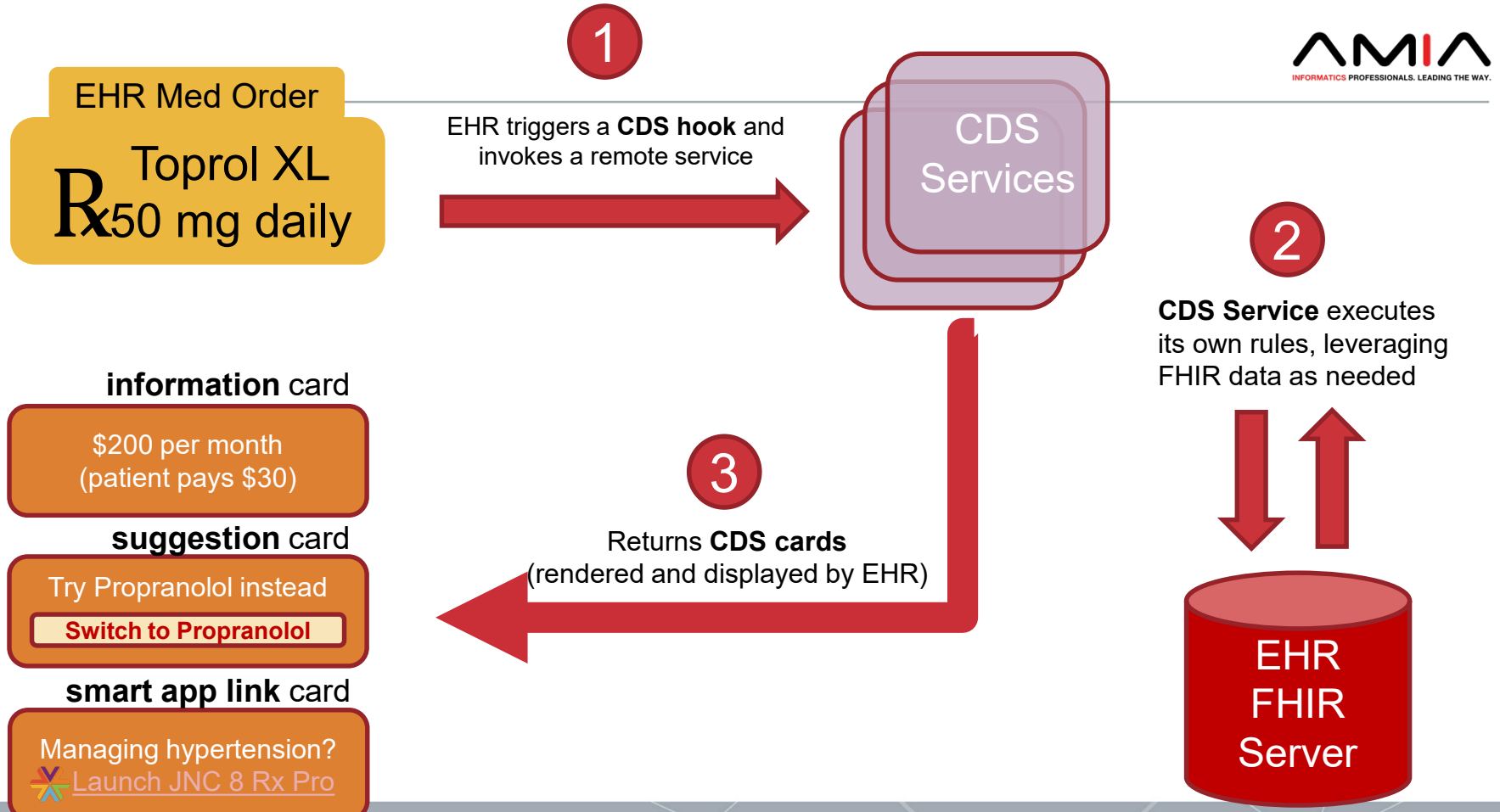
CDS Hooks

http://cds-hooks.hl7.org

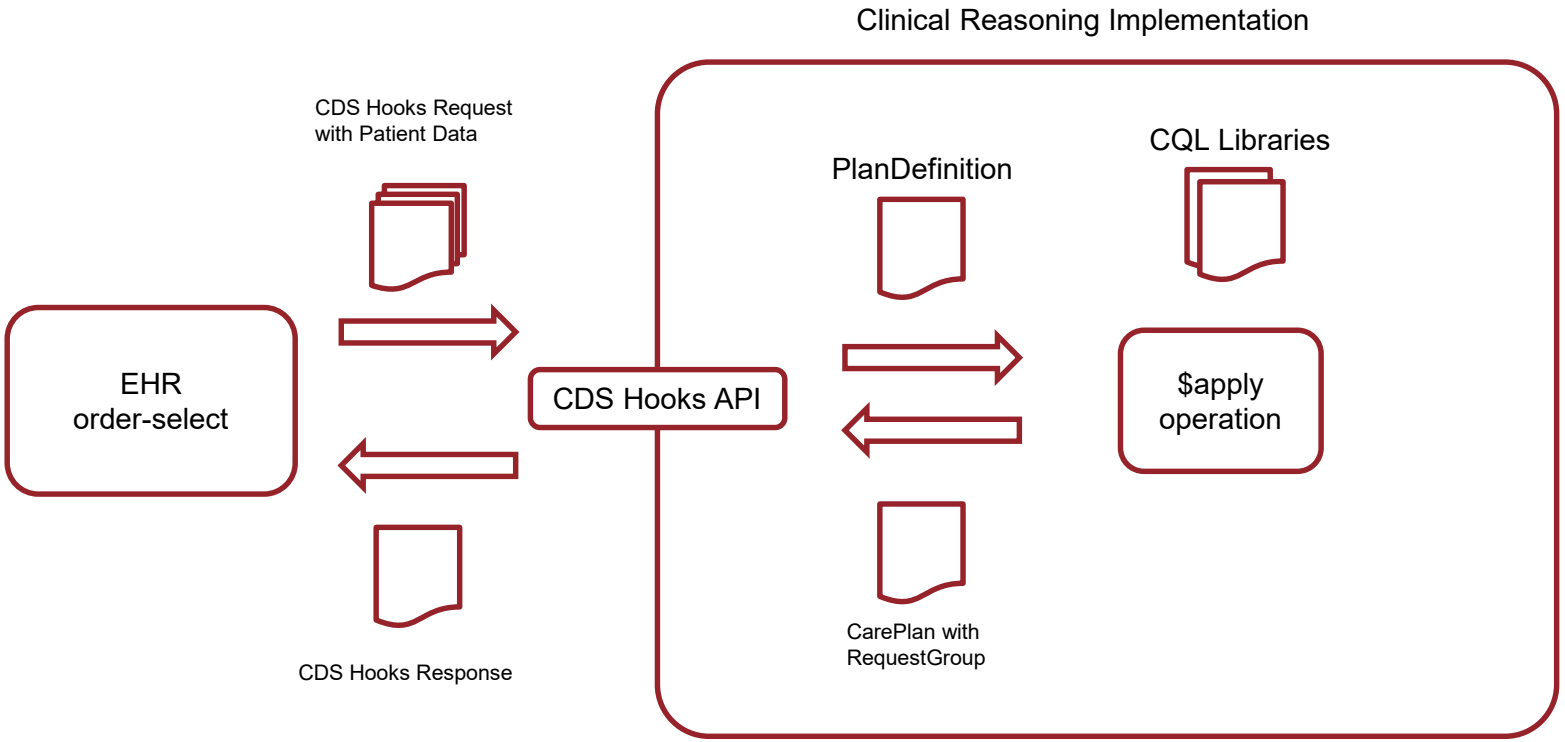
Originated from the team behind SMART

Open source via the Creative Commons Attribution 4.0 license

Published HL7 standard

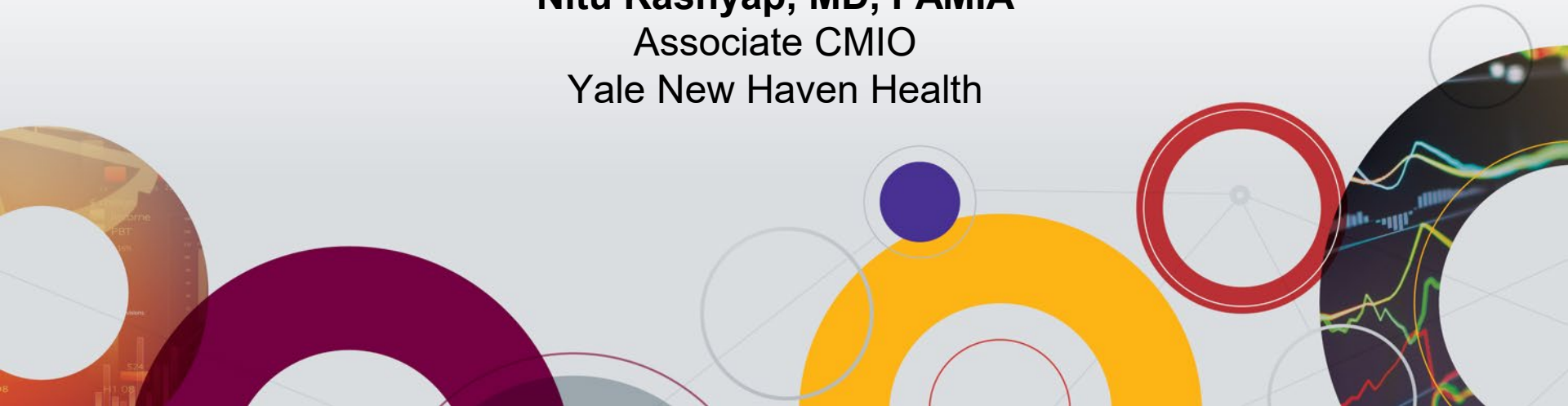

EHR Med Order
Rx Toprol XL
50 mg daily
1
EHR triggers a **CDS hook** and invokes a remote service
CDS Services
2
CDS Service executes its own rules, leveraging FHIR data as needed
EHR FHIR Server
3
Returns **CDS cards** (rendered and displayed by EHR)
information card
$200 per month (patient pays $30)
suggestion card
Try Propranolol instead
Switch to Propranolol
smart app link card
Managing hypertension?
Launch JNC 8 Rx Pro

CDS Hooks Integration



Pilot #1 (Epic, Yale, CDS Hooks)

Nitu Kashyap, MD, FAMIA
Associate CMIO
Yale New Haven Health



Outline

- Background on Yale and EHR journey
- Previous work on CDC opioids guideline – history
- Prior work on recommendation #8, native EHR tools
  - Some details, opioid registry
  - Lesson: took a long time, if this was 12, would have taken a *really* long time
- Current pilot
  - Overall data flow diagram, CQF ruler, local Epic install
  - Technical requirements / pre-requisites
  - Recommendation #10 and #11 – what it looks like (just #11), workflow around it
  - Challenges and lessons learned (from report out)
  - Where we stand, where going next

Yale New Haven Health & Yale School of Medicine

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$6.7B
revenue*

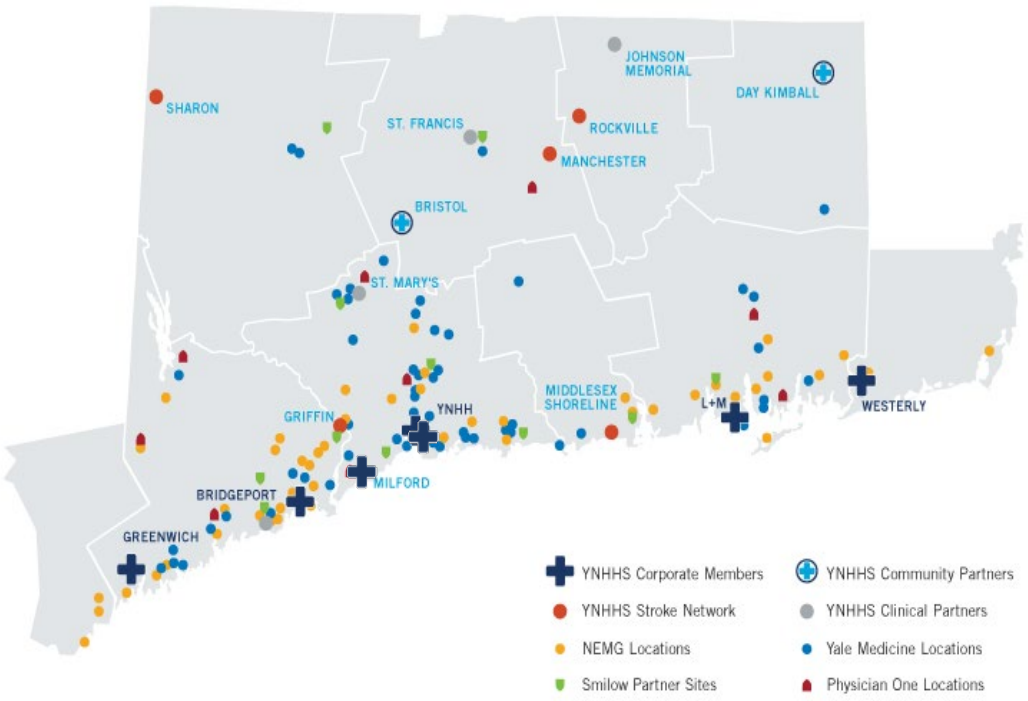
2,681
beds

271
care sites

7
hospital campuses

7,113
medical staff

26,000
employees



462,998
ED visits

172,105
inpatient admits

2.7M
ambulatory encounters

2,021 active research studies

691,930
unique patients FY19

MAGNET RECOGNIZED AMERICAN NURSES CREDENTIALING CENTER

BEST HOSPITALS U.S.News RANKINGS

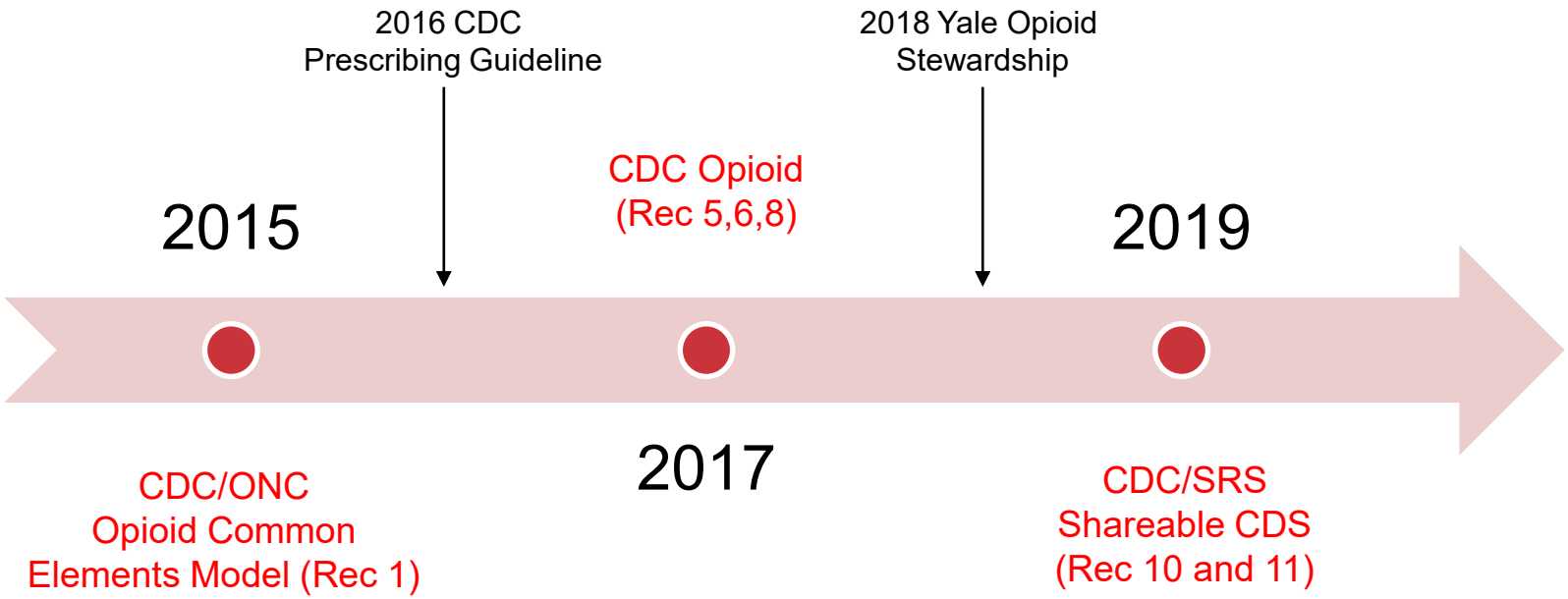
HIMSS Analytics STAGE 7

CHIME HealthCare's most wired

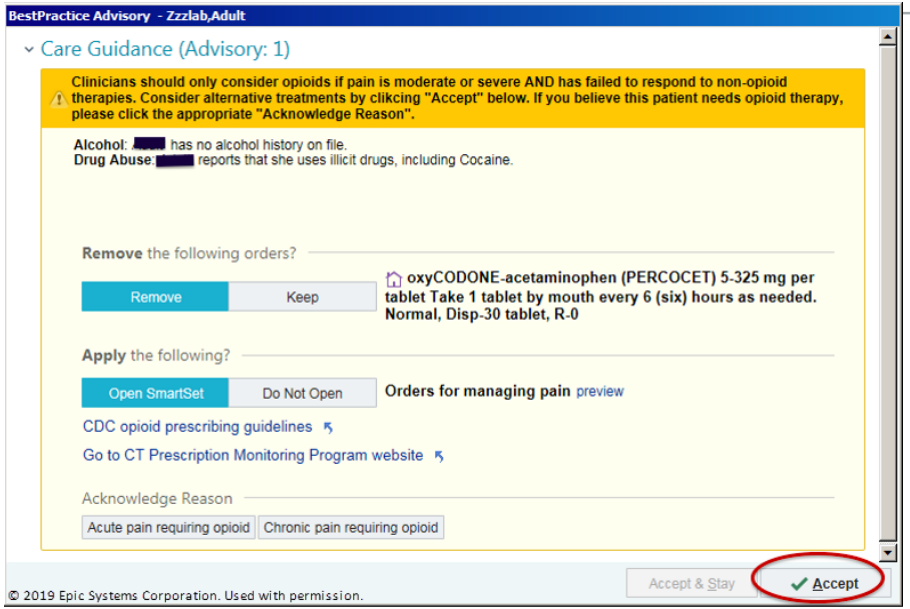
HIMSS Davies Award

HEALTHCARE EQUALITY INDEX LGBTQ HEALTHCARE EQUALITY LEADER 2019

Yale Opioid Decision Support Journey



2015: When to Consider Opioids, Alternatives



Based on several guidelines related to opioid prescriptions for treatment of chronic non-cancer pain

Common Elements in opioid prescribing guidelines

Go to CT Prescription Monitoring Program website

- **Documentation**
  - **Progress Notes**
- **Referrals- Guidelines support the use of the following modalities for use in patients with chronic pain**
- **Medications for mild to moderate pain - Try these first**
  - **First Line Medications**
  - **Muscle Relaxants**
  - **Topical Preparations**
- **Medications for moderate to severe pain**
  - **Non-Opioid pain meds**
  - **Opioids for chronic pain - Therapeutic trial, initiate with low dose and titrate slowly**
- **Labs- Urine toxicology screen**
  - **Chronic Pain Labs**
- **Patient Information / Instructions**
- **Follow up**
- **Additional SmartSet Orders**

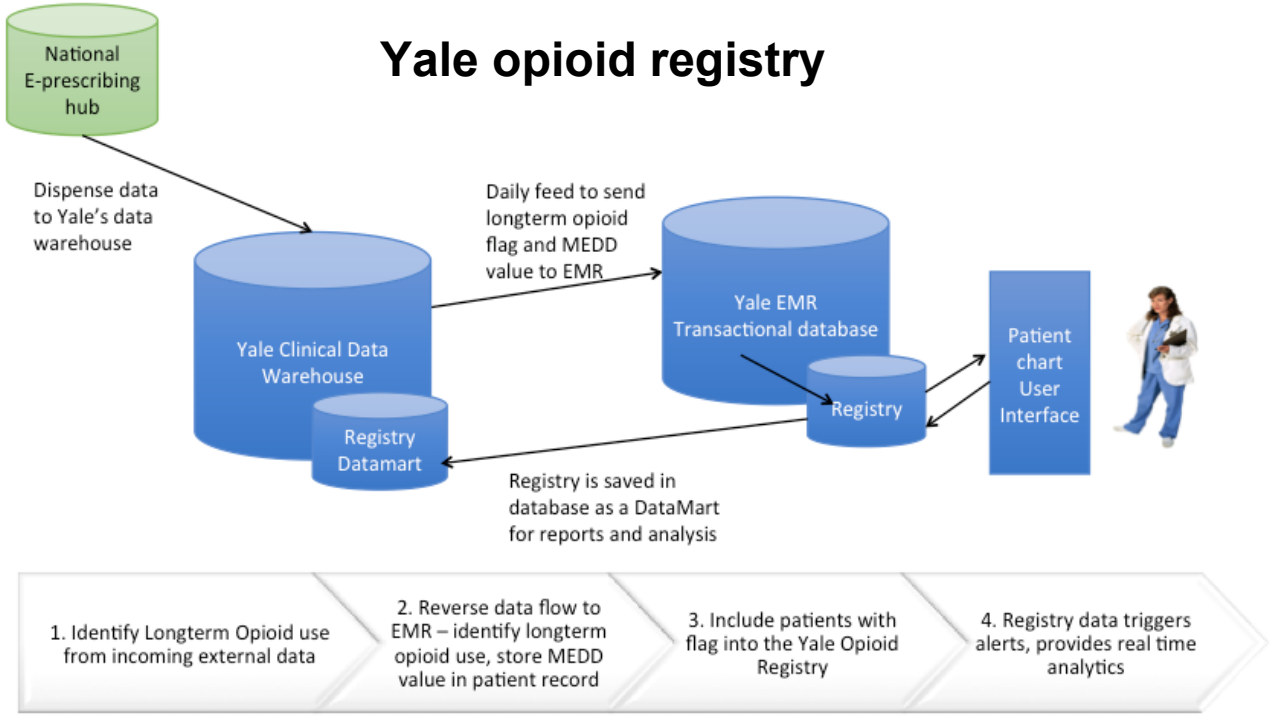
Did it work?

Sites live – 3
total fires – 1394
Alert driven actions – 186 (~13%)

Reset Filters | + Add as Restriction | Export Table

Restrict By	EHR Id	Name	Health	Usage ▼	Workflow Action	Dismissive Action	Excluded Action
	11	Acknowledge/Override Warning	0.0%	972	0	972	0
	6	Open SmartSet	100.0%	87	87	0	0
	37	Remove ERX single order	100.0%	64	64	0	0
	41	Activity Link	100.0%	2	2	0	0
	31	Accept BPA (No Action Taken)	0.0%	1	0	1	0
	32	Cancel BPA	0.0%	1	0	1	0

2017: Quantify Dose with MME, Rx Naloxone



Prime Contract OPM 1912 C O0023
Task Order Number O0022

Chronic Opioid Use and MME Calculation

- **Identify long term opioid use:** opioid dispenses covering 84 days in the past 90 day period.
- **Off the registry:** last dispensed opioid runs out and no more dispense for 30 days.
- **Calculate MME**: most recent dispensed opioids daily quantity and CDC conversion table. *Med dose x freq. x conversion factor*

Calculating morphine milligram equivalents (MME)

OPIOID (doses in mg/day except where noted)	CONVERSION FACTOR
Codeine	0.15
Fentanyl transdermal (in mcg/hr)	2.4
Hydrocodone	1
Hydromorphone	4
Methadone	
1-20 mg/day	4
21-40 mg/day	8
41-60 mg/day	10
≥ 61-80 mg/day	12
Morphine	1
Oxycodone	1.5
Oxymorphone	3

These dose conversions are estimated and cannot account for all individual differences in genetics and pharmacokinetics.

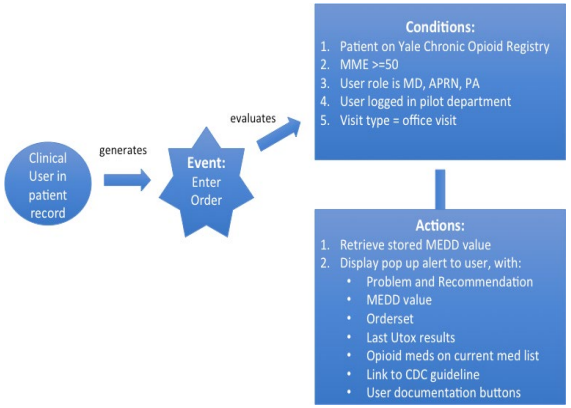
https://www.cdc.gov/drugoverdose/pdf/calculating_total_daily_dose-a.pdf

Multiple CDS Modalities

Rec 6: Default dispense for all opioids to approx. 3 day supply

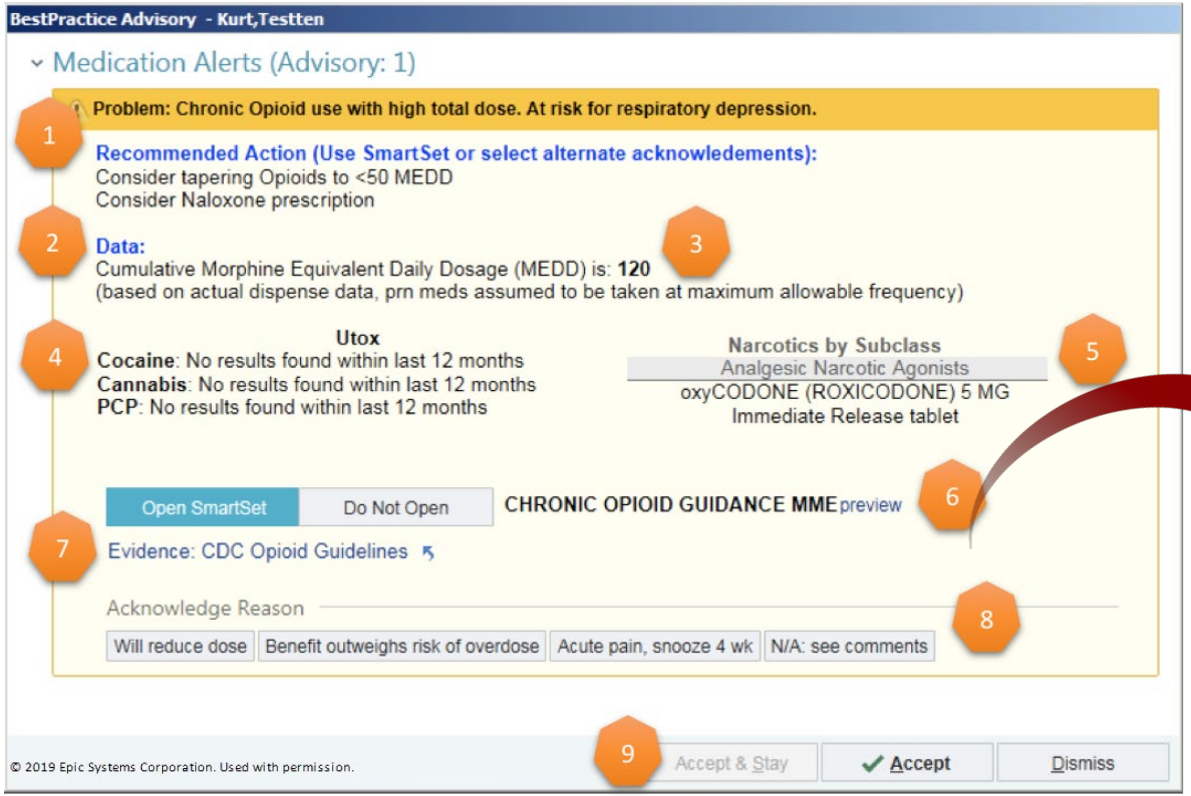
Rec 5: Calculate MME, display in reports

Rec 8: Interruptive alert if MME >50



Event-condition-Action to support Naloxone prescriptions

CDS for Recommendation 8



Early Success: Resident Clinic

- Nursing and pharmacist driven Opioid management program
- 148 patients receiving chronic opioids for non-cancer pain
- BPA fired 166 times. 43% action rate
- Results: 100% of these patients had a naloxone prescription and patient/family education documented on naloxone

CDS impact in last 6 months:
427 patients, 525 alerts
173 (40%) patients orderset opened

Lessons

- Meticulous work
- Guideline interpretations to design CDS: needs experts
- **Time consuming** to get logic right
- Significantly more effort on Usability and User expectations
- **Local ownership helps adoption**
- **Shareable and executable logic for recommendations would be helpful**

2019: Pilot Shareable and Executable Logic

Purpose

To evaluate the **feasibility** and assess the required level of **local technical expertise** needed to implement shareable clinical reasoning module (CQF Ruler) according to the CDS Hooks specification directly within EHR workflow.

Scope

1) To demonstrate shareability and executability of the clinical reasoning module (CQF Ruler) to support recommendations 10 and 11. This involves installing a local instance of the CQF Ruler based on documentation provided, as well as validating other standard terminology artifacts in Yale's Health IT ecosystem.

2) Use CDS Hooks from Yale's Epic instance to connect to the clinical reasoning module (CQF Ruler) and create test patients in the EHR to demonstrate execution of CDS based on CQF Ruler logic.

Prime Order Number: HHSP233201800320G

Nuts and Bolts: The Set Up

Local implementation of CQF-Ruler

Provision dedicated server (VM) per CQF-Ruler requirements * inside YNHH DMZ network
Setup a backup routine
Validate external access to CQF-Ruler server
Setup the enviroment to support CQF-Ruler
Install CQF-Ruler and required dependencies
Internal validation of CQF-Ruler installation

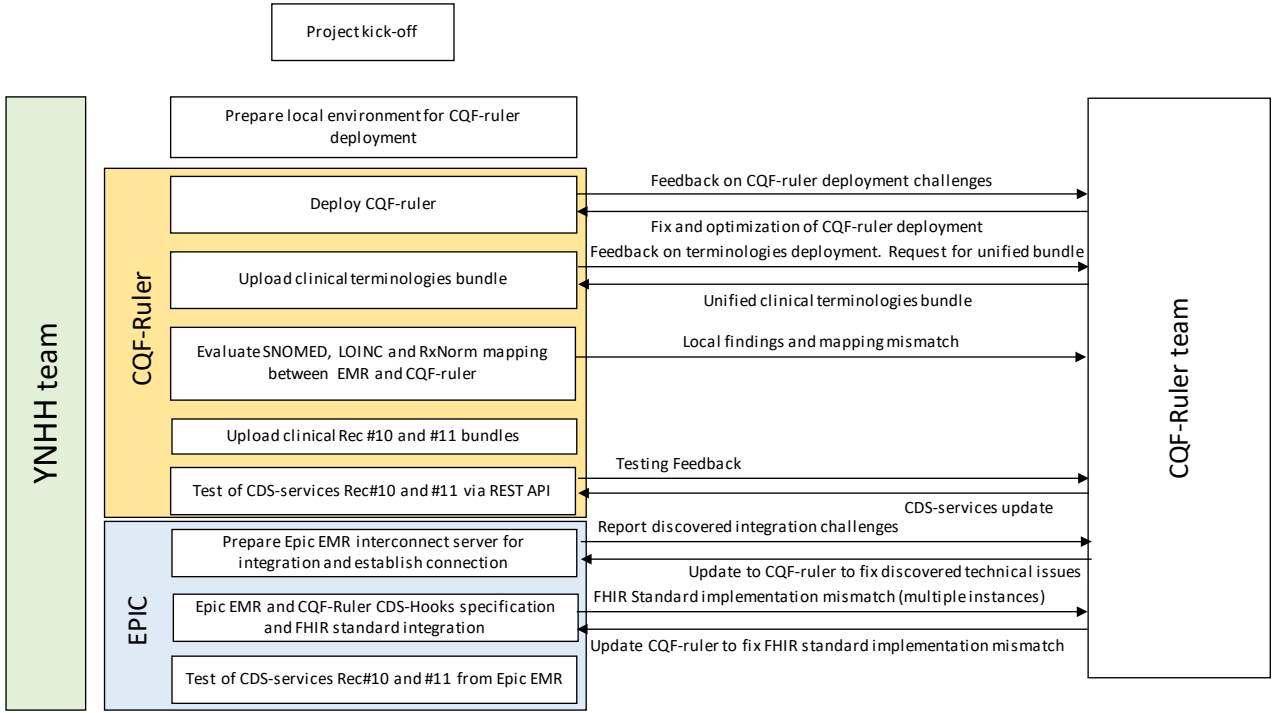
Epic Interconnect Setup

Create an Epic Interconnect queue
Setup an E0A Record

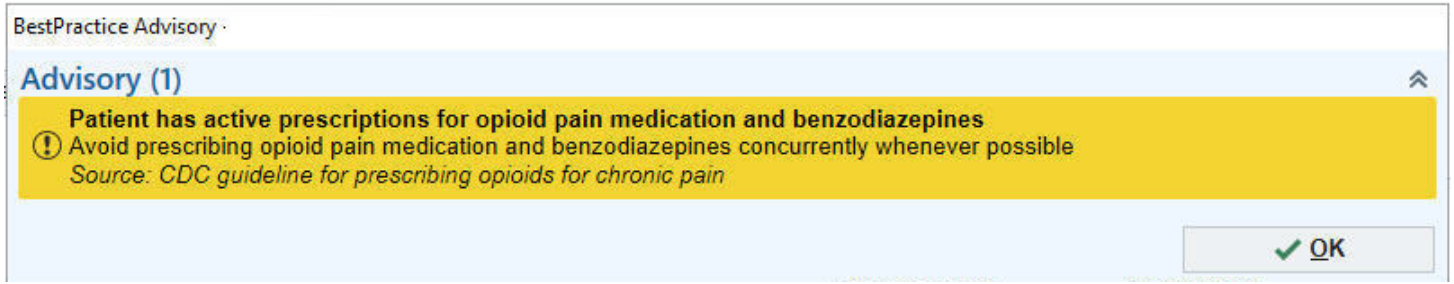
Epic EMR setup

Create Best Practice Alert (BPA) criteria rules
Link BPA to created CDS Hooks web service

Overall Data Flow



Diagrammatic representation of performed activities illustrating the dependencies and sequential nature of the tasks.



Challenges and Resolutions

Challenge	Description	Resolution
FHIR mismatch	Difference in FHIR resources b/w EHR vendor and CQF ruler, version skew and asynchronous updates	CQF ruler updated
Guideline logic updates	End-of-life meds	Branch removed from CQF logic
Functionality Gaps	Capabilities to create a scalable product	Feedback to CQF team
Standards and Terminologies	Local adoption of standard terminologies	Validation included as part of project plan
Personnel Issues	Time and skills at local sites	Task to role defined. Improve task documentation.
Performance Issues	EHR performance maybe impacted when processing data in live systems	Consider performance during CQF design, future ability to do “load testing”.

Lessons Learned

1) Shareable CDS has the potential to reduce the time taken to develop, test and deploy CDS >> expedite guideline adoption.
2) Local skills are still required for deployment and maintenance of artifacts. The depth of skills and time commitment can be reduced.
3) Multiple systems undergoing asynchronous upgrades adds to the complexity.
4) Vendor and SME engagement is critical to progress at this early stage.
5) Include test patient(s) and testing script as part of CQF instruction package.

Next Steps

- Continue to work on guidelines >> CQL logic with experts
- Iteratively improve clearinghouse functionality
- Clinical Implementation
  - End user engagement
  - Study impact/utility

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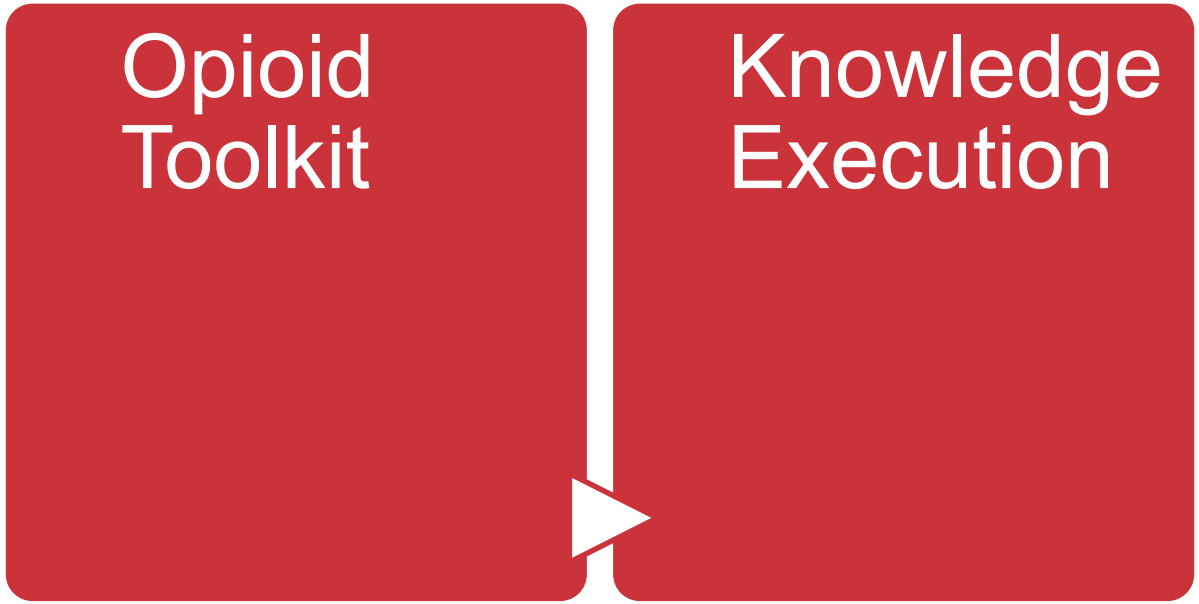
Pilot #2 (Cerner, Indiana University, CQL)

Cole Erdmann
Director, Clinical Intelligence
Cerner

Background to strategy

- Background on the project and Cerner's to support management of opioids
- Workflows and Integration of knowledge
- Lessons Learned
- Next Steps for the project

What is Cerner doing to enable this



Cerner Opioid Toolkit

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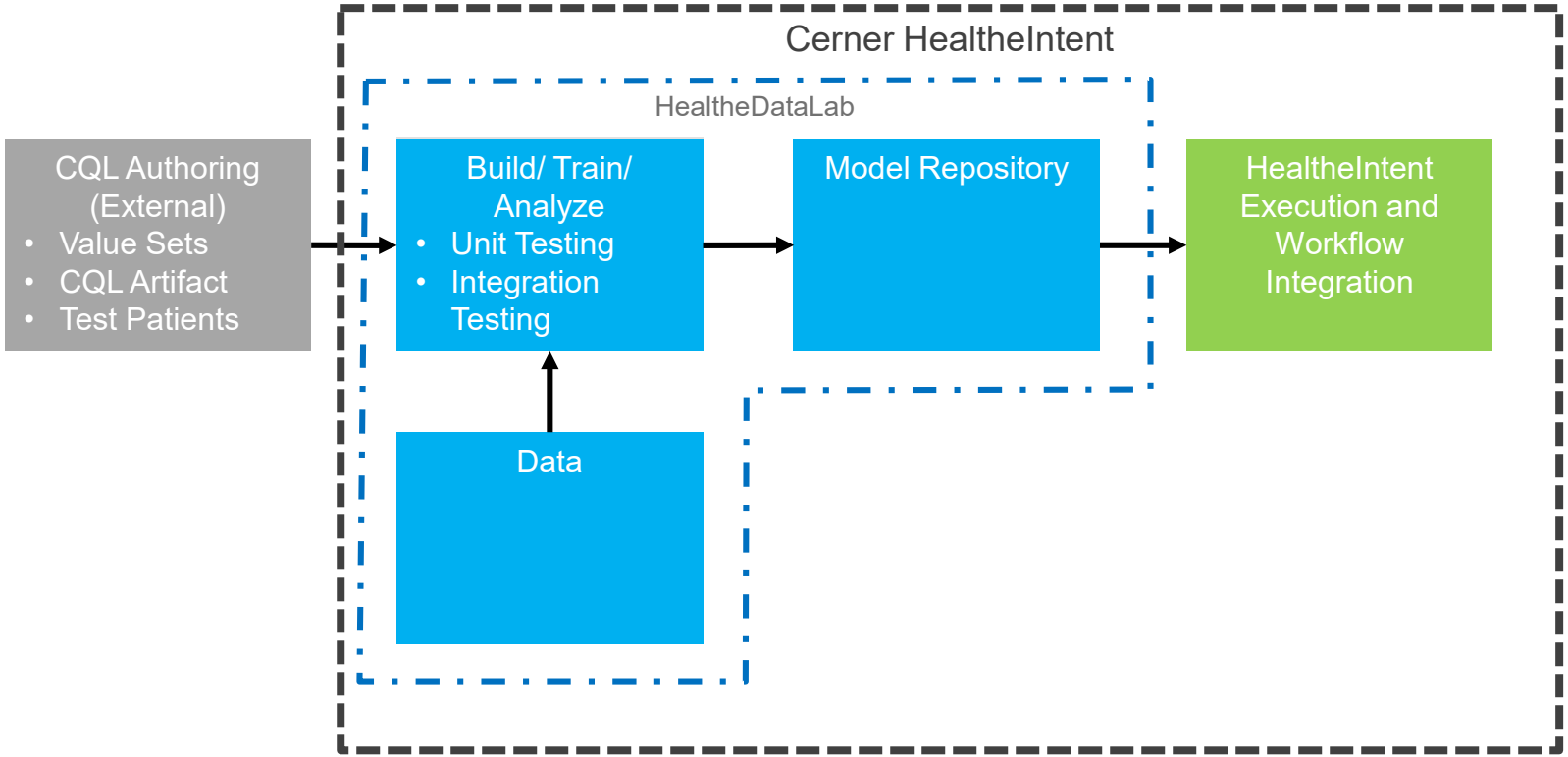
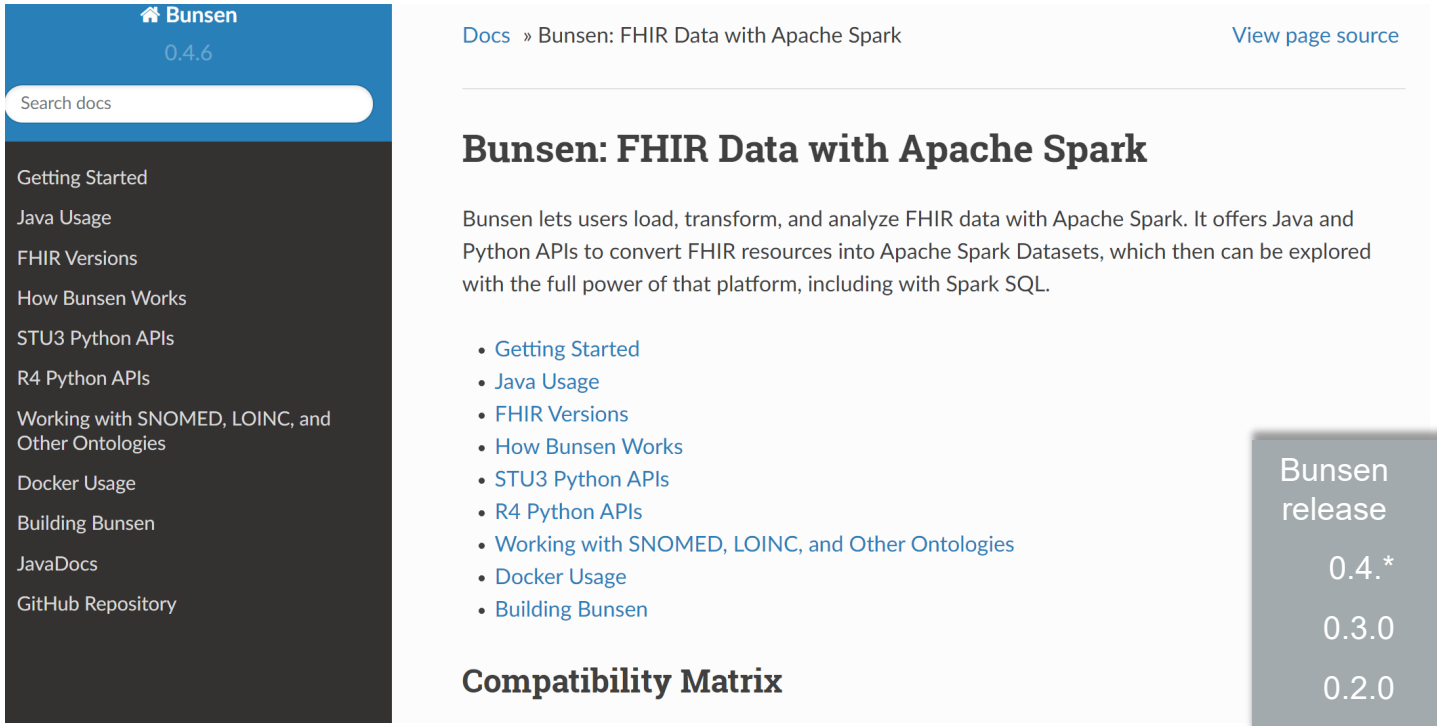
	Pain Management	Opioid Safety	Substance Use Disorder
			
Define Goals	• E.g. Manage pain effectively • E.g. Reduce reliance on opioid pain releivers	• E.g. Reduce over-prescribing • E.g. Eliminate opioid-related adverse drug events (ORADE)	• E.g. Identify individuals at risk for substance use disorder • E.g. Refer to treatment more quickly
Analyze	• Chronic pain patients with relationship with pain provider • Adoption of evidence-based practice	• Inpatient over-sedation analysis • Variance in post-op pain management • Top opioid prescribers	• Education and care offered after overdose in ED • Delay between referral to treatment and appointment scheduled • “No Show” treatment appointments
Impact	• Care Pathways based on VA/DoD chronic pain guideline, ALTO project, CDC Prescribing guideline, etc. • MME/MED calculation and analysis • Integrated referral management	• Clinical Decision Support for opioid-related adverse drug events (ORADE) • Standardized pain management contract and workflow • Sedation monitoring (e.g. POSS)	• Induction of suboxone at point of care • Prescription Drug Management Program (PDMP) Integration • Preventive Substance Use Disorder screening • Opioid Use Disorder Predictor (ML model)

Execution testing and data flow



Bunsen – Enable FHIR execution



Bunsen release	Spark version	FHIR
0.4.*	2.3	STU3, R4
0.3.0	2.2	STU3, R4
0.2.0	2.2	STU3
0.1.0	2.1	STU3

https://engineering.cerner.com/bunsen/0.4.6/

Sprints

Project work was divided into two Sprints.

Sprint 1

Technical implementation

1. Integrate CQL Logic into IU Health's data in Cerner HealtheDataLab
2. Test integration with IU Health population data

Sprint 2

Clinical User Testing

1. Design mock environment and user testing script
2. Conduct interviews and analyze responses

Demo of the data

```
In [1]: spark.sql("SHOW DATABASES").toPandas()
In [2]: query= """
        library OpioidCDS_STU3_REC_10 v
In [3]: from foresight.
        fhir_database =
        version = "2019
        fhir_databases
In [28]: read_resul
Out[28]: 113227
```

Recommendation Outcomes

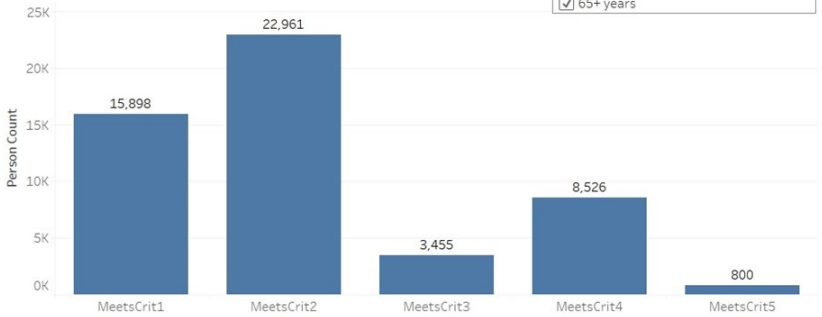
Total Population	Total Met	Excluded
113,227	36,602	26,167

Has Dx CHF: True

Gender: (All)

Age Group: (All)
- (All)
- 0-18 years
- 19-64 years
- 65+ years

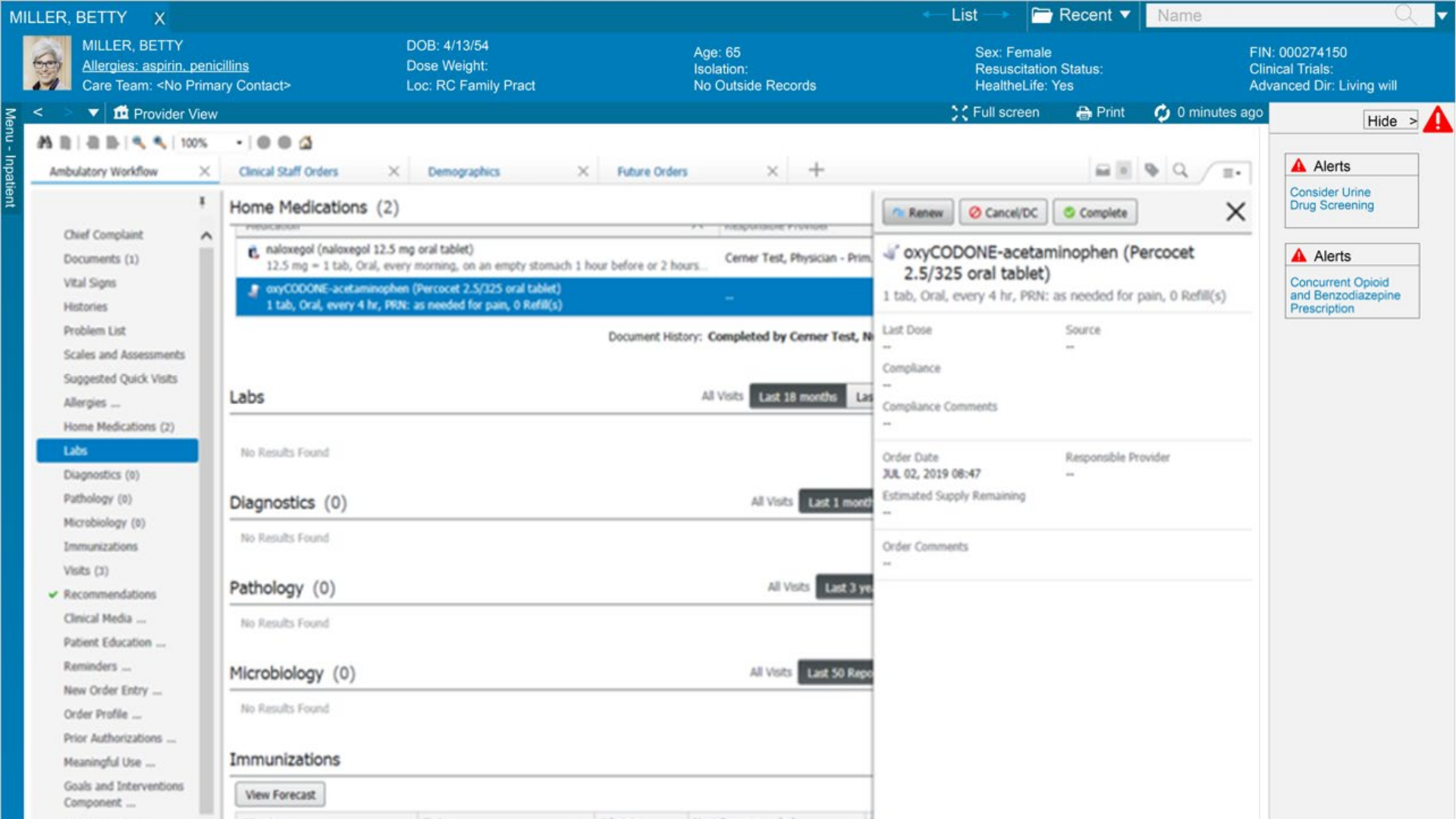
Criteria Met

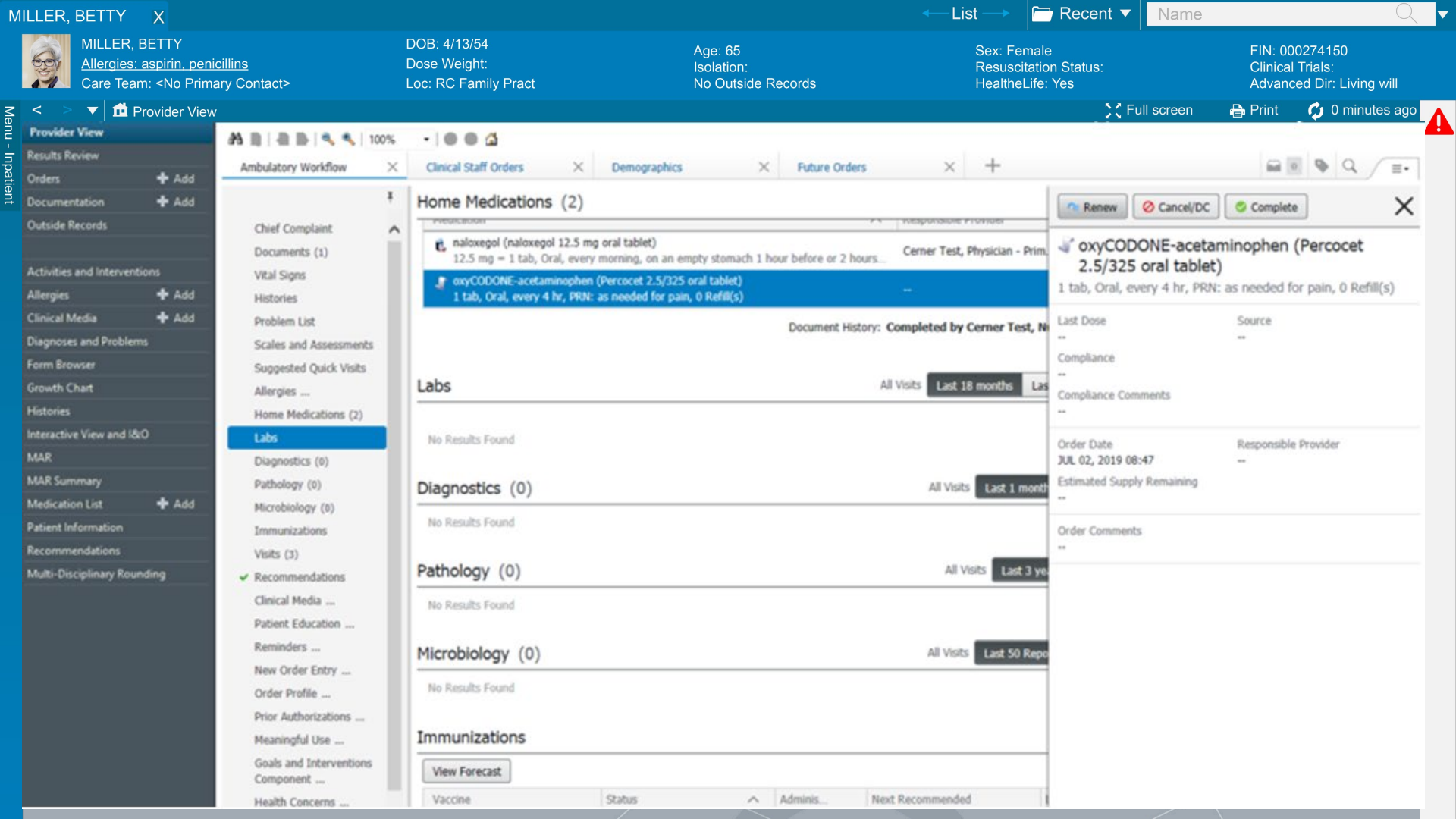


define MeetsDualCriterion1: InAgeRange19To64 and not (HasPPSV23)
define MeetsDualCriterion2: InAgeRange65AndAbove and not (HasPPSV23 or HasPCV13)
define MeetsDualCriterion3: InAgeRange65AndAbove and not (HasPPSV23) and PCV13NotGiven1Yr
define MeetsDualCriterion4: InAgeRange65AndAbove and not (HasPCV13) and PPSV23NotGiven1Yr
define MeetsDualCriterion5: InAgeRange65AndAbove and PPSV23NotGiven5Yr and HasPPSV23 and not PPSV23Age65 and PCV13NotGiven1Y

Clinical Scenario described to user group

You are in a clinic visit with one of your patients. She is a 65-year-old woman you have been seeing for 5 years. She has long-term chronic hip and knee pain from osteoarthritis. She has been on a relatively stable dose of hydrocodone/acetaminophen (Norco) throughout the time you have been treating her, with a few small increases over time. She is generally an easygoing and responsible patient from your experience. She has never had an aberrancy in a prescription drug monitoring program (INspect) check or urine drug screen (UDS). Today's visit is a routine 3 month pain visit to refill her prescription. You're at the point of the visit where you would place your orders.


MILLER, BETTY
List
Recent
Name
MILLER, BETTY
Allergies: aspirin, penicillins
Care Team: <No Primary Contact>
DOB: 4/13/54
Dose Weight:
Loc: RC Family Pract
Age: 65
Isolation:
No Outside Records
Sex: Female
Resuscitation Status:
HealtheLife: Yes
FIN: 000274150
Clinical Trials:
Advanced Dir: Living will
Menu - Inpatient
Provider View
Full screen
Print
0 minutes ago
Hide
Ambulatory Workflow
Clinical Staff Orders
Demographics
Future Orders
Chief Complaint
Documents (1)
Vital Signs
Histories
Problem List
Scales and Assessments
Suggested Quick Visits
Allergies ...
Home Medications (2)
Labs
Diagnostics (0)
Pathology (0)
Microbiology (0)
Immunizations
Visits (3)
Recommendations
Clinical Media ...
Patient Education ...
Reminders ...
New Order Entry ...
Order Profile ...
Prior Authorizations ...
Meaningful Use ...
Goals and Interventions Component ...
Home Medications (2)
naloxegol (naloxegol 12.5 mg oral tablet)
12.5 mg = 1 tab, Oral, every morning, on an empty stomach 1 hour before or 2 hours...
Cerner Test, Physician - Prim
oxyCODONE-acetaminophen (Percocet 2.5/325 oral tablet)
1 tab, Oral, every 4 hr, PRN: as needed for pain, 0 Refill(s)
Document History: Completed by Cerner Test, N
Labs
All Visits
Last 18 months
No Results Found
Diagnostics (0)
All Visits
No Results Found
Pathology (0)
All Visits
No Results Found
Microbiology (0)
All Visits
No Results Found
Immunizations
View Forecast
Renew
Cancel/DC
Complete
oxyCODONE-acetaminophen (Percocet 2.5/325 oral tablet)
1 tab, Oral, every 4 hr, PRN: as needed for pain, 0 Refill(s)
Last Dose
Source
Compliance
Compliance Comments
Order Date
JUL 02, 2019 08:47
Responsible Provider
Estimated Supply Remaining
Order Comments
Alerts
Consider Urine Drug Screening
Alerts
Concurrent Opioid and Benzodiazepine Prescription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Resuscitation Status:
HealtheLife: Yes
FIN: 000274150
Clinical Trials:
Advanced Dir: Living will
Menu - Inpatient
Provider View
Full screen
Print
0 minutes ago
Provider View
Results Review
Orders Add
Documentation Add
Outside Records
Activities and Interventions
Allergies Add
Clinical Media Add
Diagnoses and Problems
Form Browser
Growth Chart
Histories
Interactive View and I&O
MAR
MAR Summary
Medication List Add
Patient Information
Recommendations
Multi-Disciplinary Rounding
Ambulatory Workflow
Clinical Staff Orders
Demographics
Future Orders
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Pathology (0)
Microbiology (0)
Immunizations
Visits (3)
Recommendations
Clinical Media ...
Patient Education ...
Reminders ...
New Order Entry ...
Order Profile ...
Prior Authorizations ...
Meaningful Use ...
Goals and Interventions Component ...
Health Concerns ...
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Labs
All Visits
Last 18 months
No Results Found
Diagnostics (0)
All Visits
Last 1 month
No Results Found
Pathology (0)
All Visits
Last 3 ye
No Results Found
Microbiology (0)
All Visits
Last 50 Repo
No Results Found
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Last Dose
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Source
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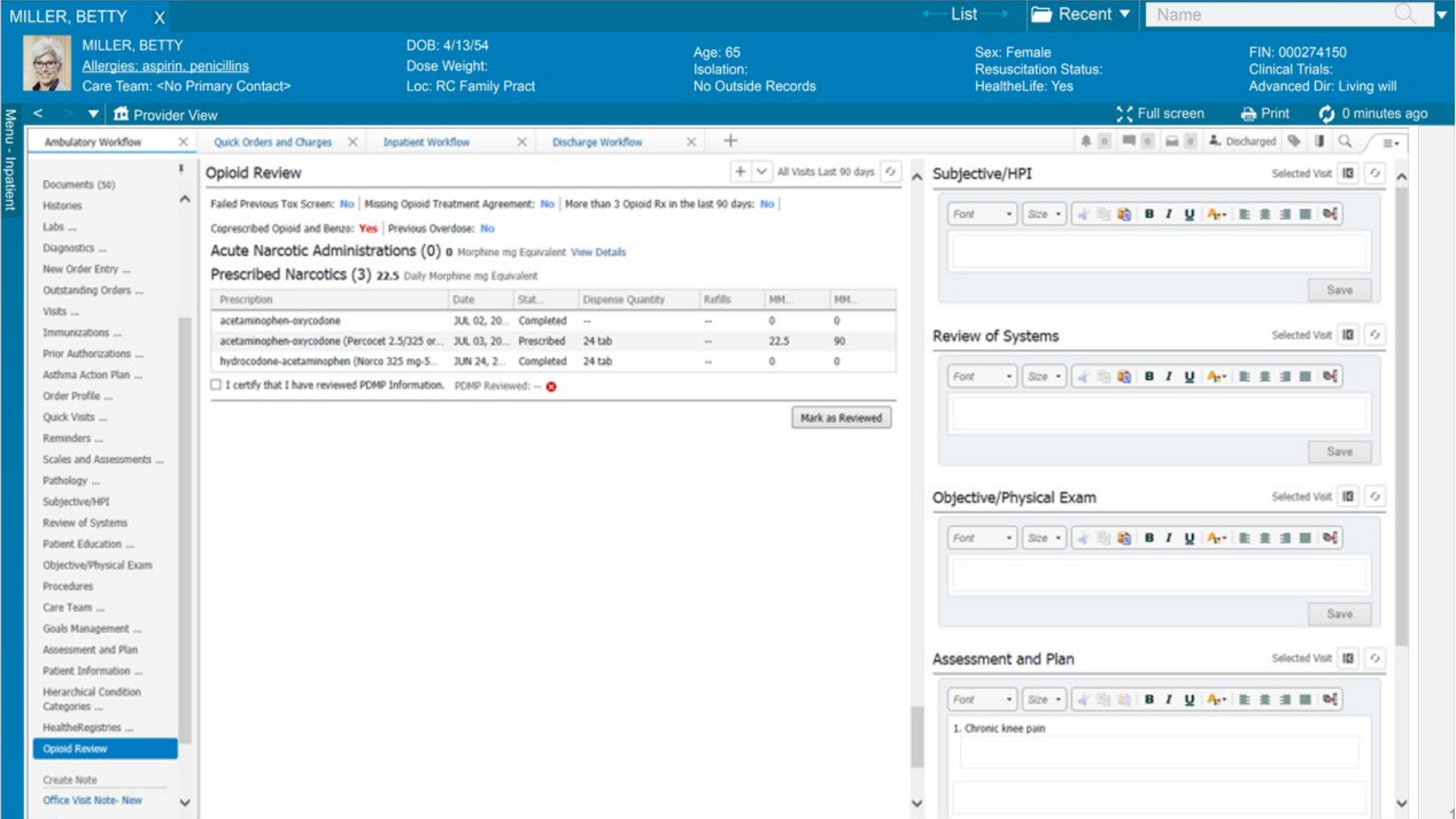
Compliance
--
Compliance Comments
--
Order Date
JUL 02, 2019 08:47
Responsible Provider
--
Estimated Supply Remaining
--
Order Comments
--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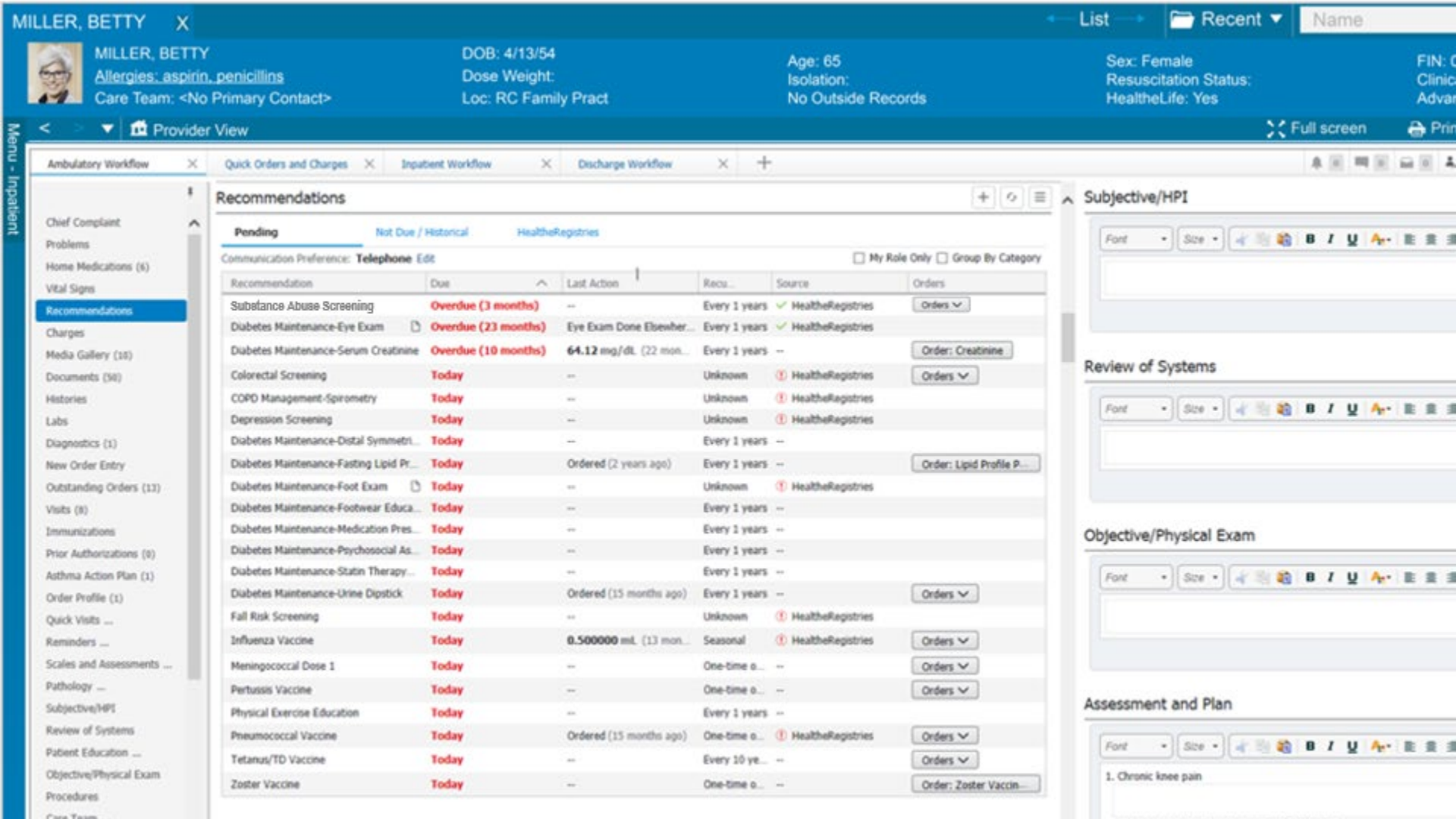
Discharge Workflow
Discharged
Documents (50)
Histories
Labs ...
Diagnostics ...
New Order Entry ...
Outstanding Orders ...
Visits ...
Immunizations ...
Prior Authorizations ...
Asthma Action Plan ...
Order Profile ...
Quick Visits ...
Reminders ...
Scales and Assessments ...
Pathology ...
Subjective/HPI
Review of Systems
Patient Education ...
Objective/Physical Exam
Procedures
Care Team ...
Goals Management ...
Assessment and Plan
Patient Information ...
Hierarchical Condition Categories ...
HealtheRegistries ...
Opioid Review
Create Note
Office Visit Note- New
Opioid Review
All Visits Last 90 days
Failed Previous Tox Screen: No | Missing Opioid Treatment Agreement: No | More than 3 Opioid Rx in the last 90 days: No |
Coprescribed Opioid and Benzo: Yes | Previous Overdose: No
Acute Narcotic Administrations (0) 0 Morphine mg Equivalent View Details
Prescribed Narcotics (3) 22.5 Daily Morphine mg Equivalent
Prescription | Date | Stat... | Dispense Quantity | Refills | MM... | MM...
acetaminophen-oxycodone | JUL 02, 20... | Completed | -- | -- | 0 | 0
acetaminophen-oxycodone (Percocet 2.5/325 or... | JUL 03, 20... | Prescribed | 24 tab | -- | 22.5 | 90
hydrocodone-acetaminophen (Norco 325 mg-5... | JUN 24, 2... | Completed | 24 tab | -- | 0 | 0
I certify that I have reviewed PDMP Information. PDMP Reviewed: --
Mark as Reviewed
Subjective/HPI
Selected Visit
Font
Size
Save
Review of Systems
Selected Visit
Font
Size
Save
Objective/Physical Exam
Selected Visit
Font
Size
Save
Assessment and Plan
Selected Visit
Font
Size
1. Chronic knee pain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Inpatient Workflow
Discharge Workflow
Chief Complaint
Problems
Home Medications (6)
Vital Signs
Recommendations
Charges
Media Gallery (18)
Documents (58)
Histories
Labs
Diagnostics (1)
New Order Entry
Outstanding Orders (13)
Visits (8)
Immunizations
Prior Authorizations (8)
Asthma Action Plan (1)
Order Profile (1)
Quick Visits ...
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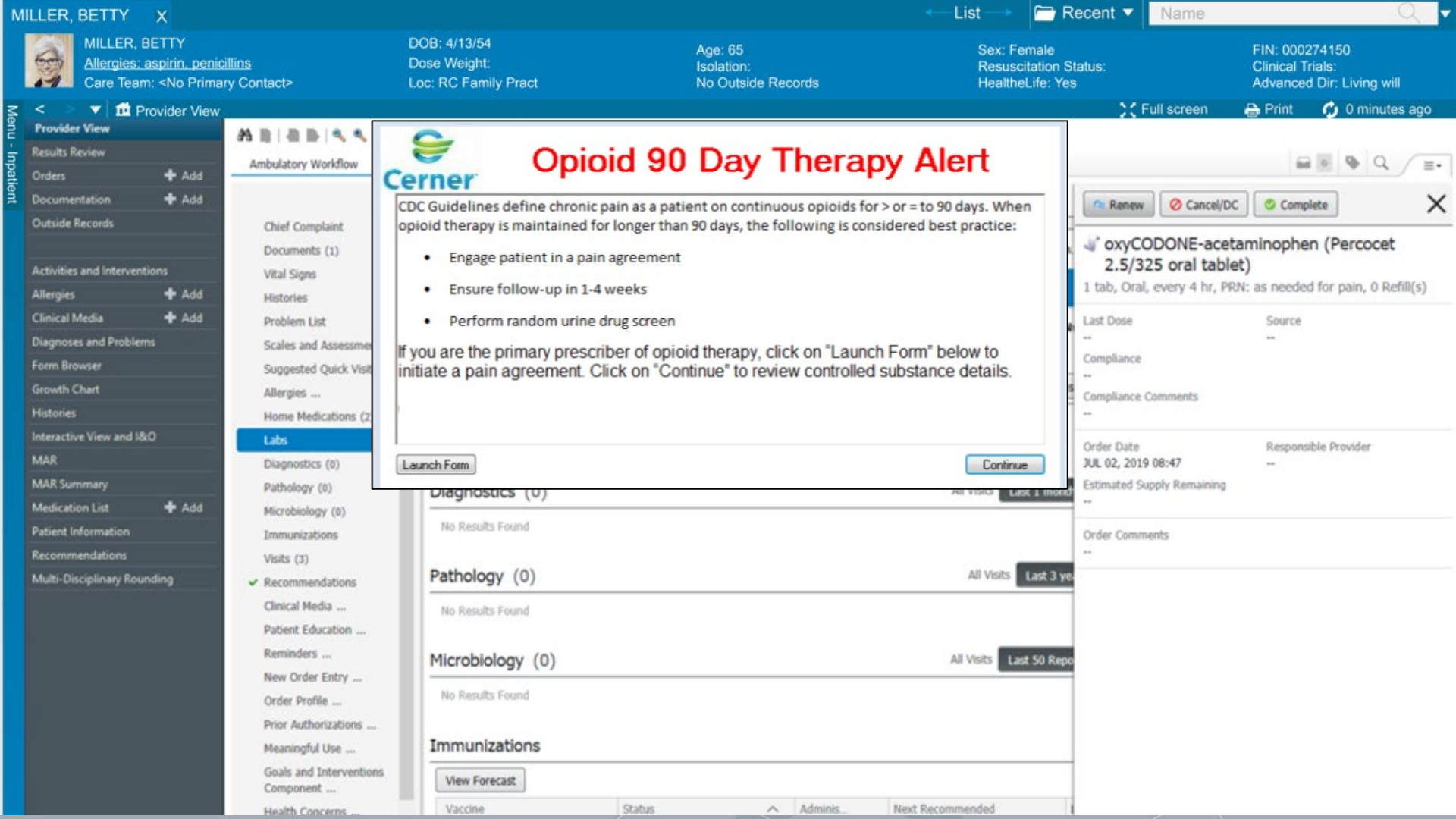
Subjective/HPI
Review of Systems
Patient Education ...
Objective/Physical Exam
Procedures
Recommendations
Pending
Not Due / Historical
HealtheRegistries
Communication Preference: Telephone Edit
My Role Only
Group By Category
Recommendation
Due
Last Action
Recu...
Source
Orders
Substance Abuse Screening
Overdue (3 months)
--
Every 1 years
HealtheRegistries
Orders
Diabetes Maintenance-Eye Exam
Overdue (23 months)
Eye Exam Done Elsewher...
Every 1 years
HealtheRegistries
Diabetes Maintenance-Serum Creatinine
Overdue (10 months)
64.12 mg/dL (22 mon...
Every 1 years
--
Order: Creatinine
Colorectal Screening
Today
--
Unknown
HealtheRegistries
Orders
COPD Management-Spirometry
Today
--
Unknown
HealtheRegistries
Depression Screening
Today
--
Unknown
HealtheRegistries
Diabetes Maintenance-Distal Symmetri...
Today
--
Every 1 years
--
Diabetes Maintenance-Fasting Lipid Pr...
Today
Ordered (2 years ago)
Every 1 years
--
Order: Lipid Profile P...
Diabetes Maintenance-Foot Exam
Today
--
Unknown
HealtheRegistries
Diabetes Maintenance-Footwear Educa...
Today
--
Every 1 years
--
Diabetes Maintenance-Medication Pres...
Today
--
Every 1 years
--
Diabetes Maintenance-Psychosocial As...
Today
--
Every 1 years
--
Diabetes Maintenance-Statin Therapy...
Today
--
Every 1 years
--
Diabetes Maintenance-Urine Dipstick
Today
Ordered (15 months ago)
Every 1 years
--
Orders
Fall Risk Screening
Today
--
Unknown
HealtheRegistries
Influenza Vaccine
Today
0.500000 mL (13 mon...
Seasonal
HealtheRegistries
Orders
Meningococcal Dose 1
Today
--
One-time o...
--
Orders
Pertussis Vaccine
Today
--
One-time o...
--
Orders
Physical Exercise Education
Today
--
Every 1 years
--
Pneumococcal Vaccine
Today
Ordered (15 months ago)
One-time o...
HealtheRegistries
Orders
Tetanus/TD Vaccine
Today
--
Every 10 ye...
--
Orders
Zoster Vaccine
Today
--
One-time o...
--
Order: Zoster Vaccin...
Subjective/HPI
Font
Size
Review of Systems
Objective/Physical Exam
Assessment and Plan
1. Chronic knee pain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Advanced Dir: Living will
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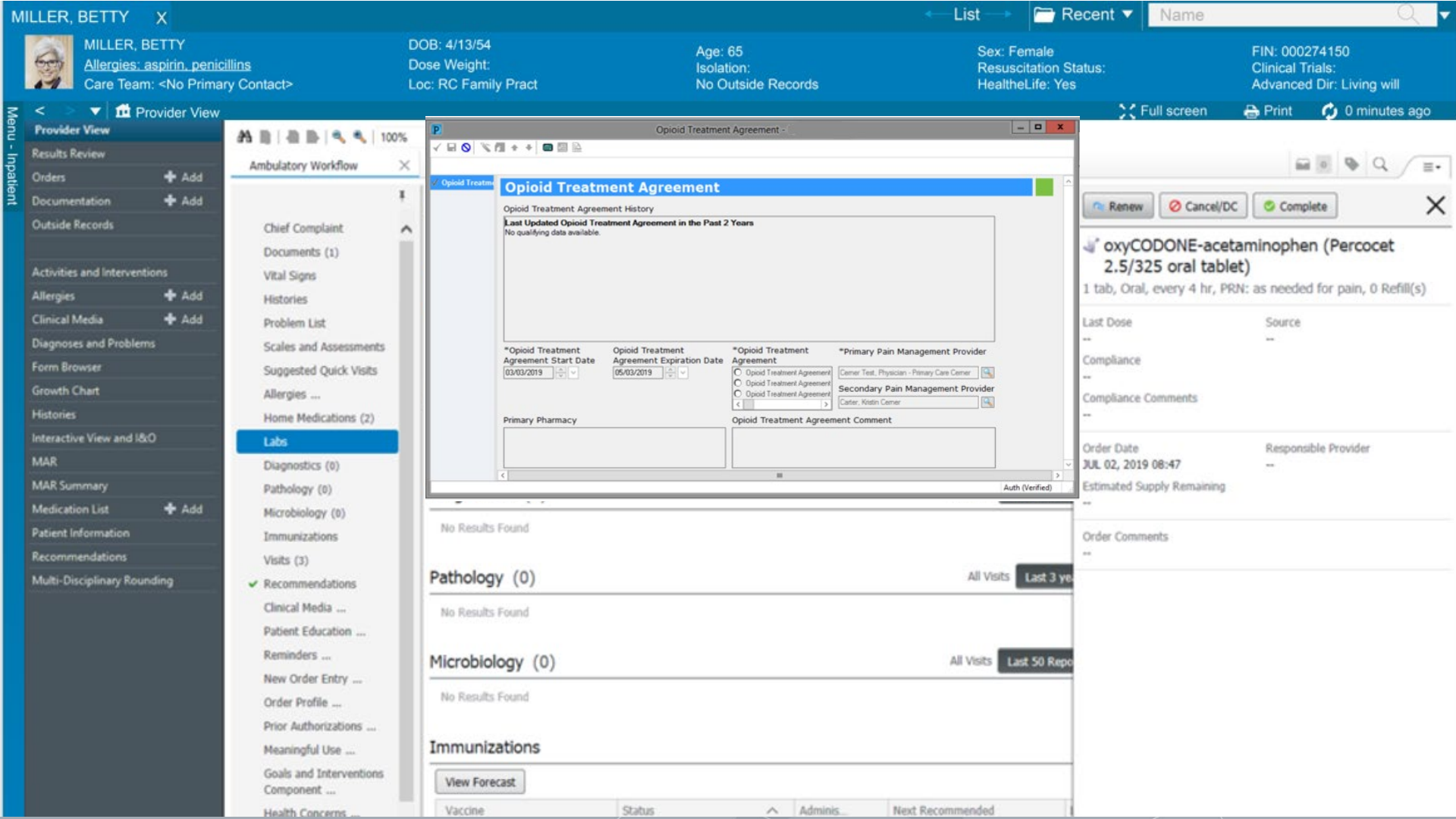
Print
0 minutes ago
Menu - Inpatient
Provider View
Results Review
Orders
Add
Documentation
Add
Outside Records
Activities and Interventions
Allergies
Add
Clinical Media
Add
Diagnoses and Problems
Form Browser
Growth Chart
Histories
Interactive View and I&O
MAR
MAR Summary
Medication List
Add
Patient Information
Recommendations
Multi-Disciplinary Rounding
Ambulatory Workflow
Chief Complaint
Documents (1)
Vital Signs
Histories
Problem List
Scales and Assessme
Suggested Quick Visit
Allergies ...
Home Medications (2
Labs
Diagnostics (0)
Pathology (0)
Microbiology (0)
Immunizations
Visits (3)
Recommendations
Clinical Media ...
Patient Education ...
Reminders ...
New Order Entry ...
Order Profile ...
Prior Authorizations ...
Meaningful Use ...
Goals and Interventions Component ...
Health Concerns ...
Cerner
Opioid 90 Day Therapy Alert
CDC Guidelines define chronic pain as a patient on continuous opioids for > or = to 90 days. When opioid therapy is maintained for longer than 90 days, the following is considered best practice:
Engage patient in a pain agreement
Ensure follow-up in 1-4 weeks
Perform random urine drug screen
If you are the primary prescriber of opioid therapy, click on "Launch Form" below to initiate a pain agreement. Click on "Continue" to review controlled substance details.
Launch Form
Continue
Diagnostics (0)
No Results Found
Pathology (0)
All Visits
No Results Found
Microbiology (0)
All Visits
No Results Found
Immunizations
View Forecast
Vaccine
Status
Adminis...
Next Recommended
Renew
Cancel/DC
Complete
oxyCODONE-acetaminophen (Percocet 2.5/325 oral tablet)
1 tab, Oral, every 4 hr, PRN: as needed for pain, 0 Refill(s)
Last Dose
Source
Compliance
Compliance Comments
Order Date
JUL 02, 2019 08:47
Responsible Provider
Estimated Supply Remaining
Order Comments


MILLER, BETTY X
List
Recent
Name
MILLER, BETTY
Allergies: aspirin, penicillins
Care Team: <No Primary Contact>
DOB: 4/13/54
Dose Weight:
Loc: RC Family Pract
Age: 65
Isolation:
No Outside Records
Sex: Female
Resuscitation Status:
HealtheLife: Yes
FIN: 000274150
Clinical Trials:
Advanced Dir: Living will
Menu - Inpatient
Provider View
Full screen
Print
0 minutes ago
Provider View
Results Review
Orders
Add
Documentation
Add
Outside Records
Activities and Interventions
Allergies
Add
Clinical Media
Add
Diagnoses and Problems
Form Browser
Growth Chart
Histories
Interactive View and I&O
MAR
MAR Summary
Medication List
Add
Patient Information
Recommendations
Multi-Disciplinary Rounding
100%
Ambulatory Workflow
Chief Complaint
Documents (1)
Vital Signs
Histories
Problem List
Scales and Assessments
Suggested Quick Visits
Allergies ...
Home Medications (2)
Labs
Diagnostics (0)
Pathology (0)
Microbiology (0)
Immunizations
Visits (3)
Recommendations
Clinical Media ...
Patient Education ...
Reminders ...
New Order Entry ...
Order Profile ...
Prior Authorizations ...
Meaningful Use ...
Goals and Interventions Component ...
Health Concerns ...
Opioid Treatment Agreement -
Opioid Treatment Agreement
Opioid Treatment Agreement History
Last Updated Opioid Treatment Agreement in the Past 2 Years
No qualifying data available.
*Opioid Treatment Agreement Start Date
03/03/2019
Opioid Treatment Agreement Expiration Date
05/03/2019
*Opioid Treatment Agreement
Opioid Treatment Agreement
Opioid Treatment Agreement
Opioid Treatment Agreement
*Primary Pain Management Provider
Cerner Test, Physician - Primary Care Cerner
Secondary Pain Management Provider
Carter, Kristin Cerner
Primary Pharmacy
Opioid Treatment Agreement Comment
Auth (Verified)
No Results Found
Pathology (0)
All Visits
Last 3 ye
No Results Found
Microbiology (0)
All Visits
Last 50 Repo
No Results Found
Immunizations
View Forecast
Vaccine
Status
Adminis...
Next Recommended
Renew
Cancel/DC
Complete
oxyCODONE-acetaminophen (Percocet 2.5/325 oral tablet)
1 tab, Oral, every 4 hr, PRN: as needed for pain, 0 Refill(s)
Last Dose
--
Source
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Compliance
--
Compliance Comments
--
Order Date
JUL 02, 2019 08:47
Responsible Provider
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Estimated Supply Remaining
--
Order Comments
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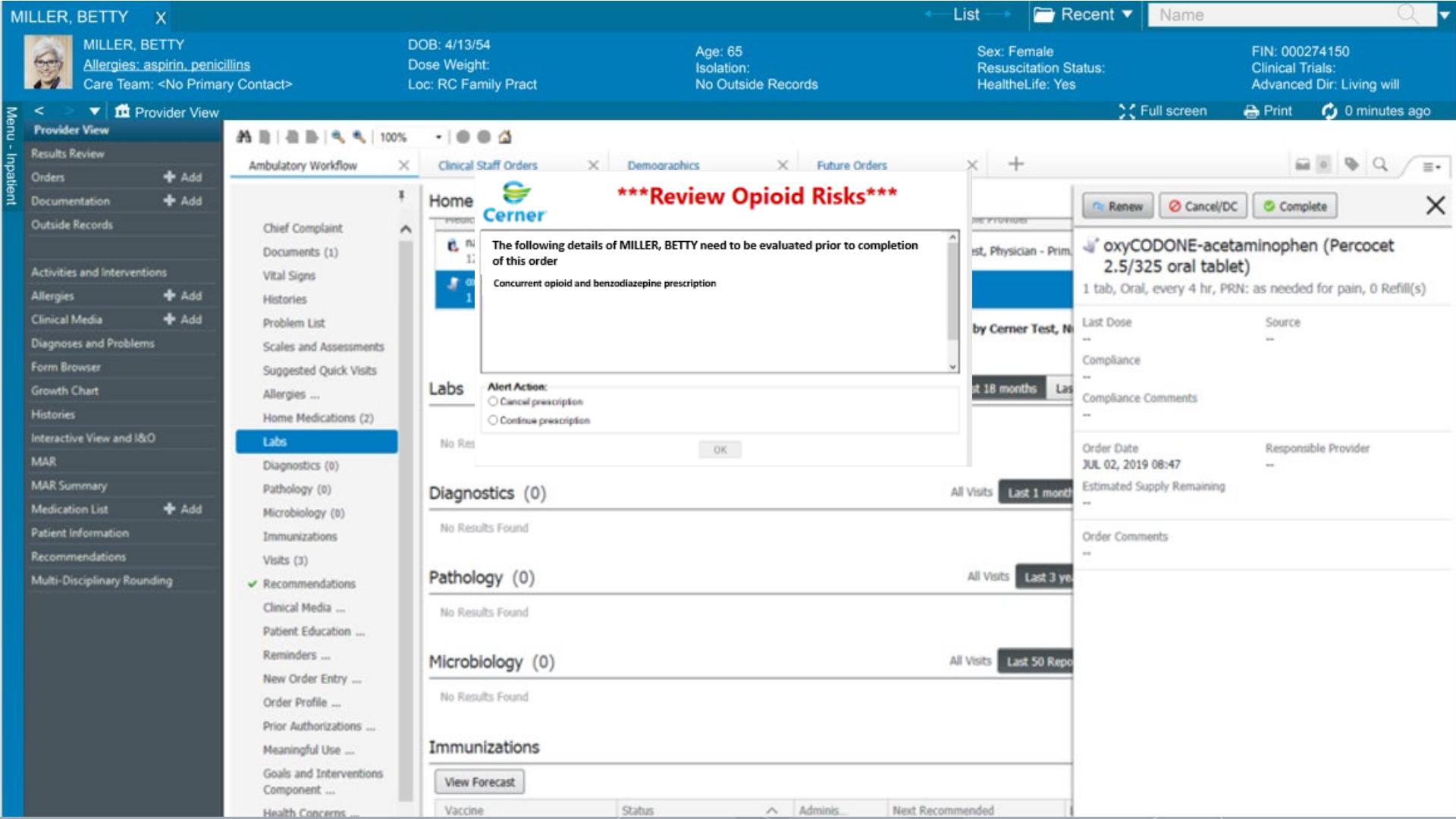
MILLER, BETTY
List
Recent
Name
MILLER, BETTY
Allergies: aspirin, penicillins
Care Team: <No Primary Contact>
DOB: 4/13/54
Dose Weight:
Loc: RC Family Pract
Age: 65
Isolation:
No Outside Records
Sex: Female
Resuscitation Status:
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Clinical Media
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Histories
Interactive View and I&O
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MAR Summary
Medication List
Add
Patient Information
Recommendations
Multi-Disciplinary Rounding
Ambulatory Workflow
Clinical Staff Orders
Demographics
Future Orders
Chief Complaint
Documents (1)
Vital Signs
Histories
Problem List
Scales and Assessments
Suggested Quick Visits
Allergies ...
Home Medications (2)
Labs
Diagnostics (0)
Pathology (0)
Microbiology (0)
Immunizations
Visits (3)
Recommendations
Clinical Media ...
Patient Education ...
Reminders ...
New Order Entry ...
Order Profile ...
Prior Authorizations ...
Meaningful Use ...
Goals and Interventions Component ...
Health Concerns ...
Home
Cerner
Review Opioid Risks
The following details of MILLER, BETTY need to be evaluated prior to completion of this order
Concurrent opioid and benzodiazepine prescription
Alert Action:
Cancel prescription
Continue prescription
OK
Labs
Diagnostics (0)
All Visits
Last 1 month
No Results Found
Pathology (0)
All Visits
No Results Found
Microbiology (0)
All Visits
No Results Found
Immunizations
View Forecast
Vaccine
Status
Adminis...
Next Recommended
Renew
Cancel/DC
Complete
oxyCODONE-acetaminophen (Percocet 2.5/325 oral tablet)
1 tab, Oral, every 4 hr, PRN: as needed for pain, 0 Refill(s)
Last Dose
Source
Compliance
Compliance Comments
Order Date
JUL 02, 2019 08:47
Responsible Provider
Estimated Supply Remaining
Order Comments

Opioid Alert for High Risk Patients

Concurrent use of any opioid with any benzodiazepine or sedative

High daily doses of opioids (greater than 50 morphine milligram equivalents)

Underlying mental health disorder

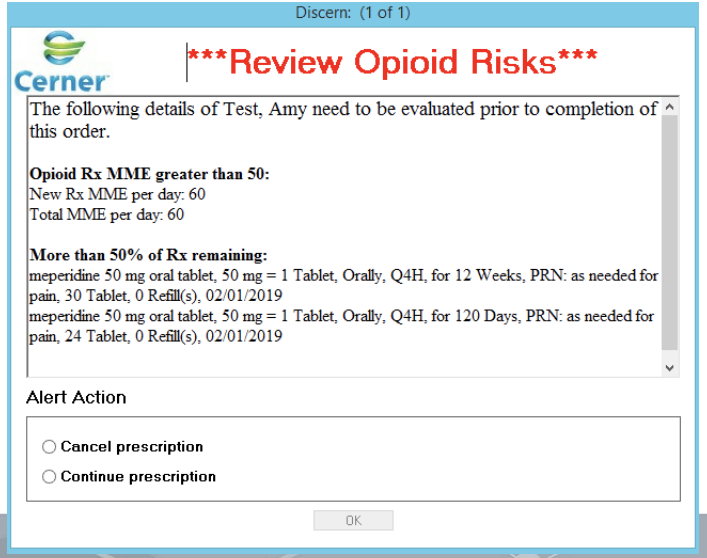
Respiratory disorder

Renal/liver disease or other related disorders

Any active illicit drug use

History of opioid overdose or over-sedation

Use of Long-acting medication in naïve patient



Lessons Learned

Three recommendations that would have improved our integration experience are:

1) including the entire query in the CQL artifact rather than referencing shared queries or external data sources;
2) publishing test patients alongside CQL queries and value sets; and
3) defining explicit intent behind how and why specific CQL functions are used in the knowledge artifact.
4) Clinicians have low tolerance for alerting inaccuracies and prefer passive rather than interruptive alerts.

Next Steps

Cerner is making recommendations 10 and 11 available for clients

There will be two incremental progress releases between now and then to provide support for the newly added operators.

We are still working to validate data on the implementation with IU Health patient population data from HealtheIntent and return analytics and aggregate results to the rest of the team.

IU team will continue to recruit IU Health primary care providers and PharmDs to get more feedback about how best to implement a clinical decision support tool to support opioid prescribing

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Thank you!

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